

Endangered Species Act Section 7  
Consultation  
and  
Magnuson-Stevens Act  
Essential Fish Habitat Consultation

BIOLOGICAL OPINION

IMPACTS OF TREATY INDIAN AND NON-INDIAN FALL SEASON  
FISHERIES IN THE COLUMBIA RIVER BASIN IN YEAR 2002  
ON SALMON AND STEELHEAD LISTED UNDER THE  
ENDANGERED SPECIES ACT

Agency: U.S. Fish and Wildlife Service  
National Marine Fisheries Service  
Bureau of Indian Affairs

Consultation Conducted By: National Marine Fisheries Service,  
Northwest Region

Date Issued: AUG 15 2002

## Table of Contents

INTRODUCTION .....	-1-
CONSULTATION HISTORY .....	-1-
BIOLOGICAL OPINION .....	-2-
1.0 DESCRIPTION OF THE PROPOSED ACTION .....	-2-
1.1 Proposed Action .....	-2-
1.2 Action Area .....	-3-
2.0 STATUS OF SPECIES AND CRITICAL HABITAT .....	-3-
2.1 Species Descriptions and Critical Habitat Designations .....	-5-
2.1.1 Chinook Salmon .....	-5-
2.1.2 Steelhead .....	-6-
2.1.3 Chum Salmon .....	-7-
2.2 General Life History .....	-7-
2.2.1 Chinook Salmon .....	-7-
2.2.2 Steelhead .....	-8-
2.2.3 Chum Salmon .....	-9-
2.3 Population Dynamics and Distribution .....	-10-
2.3.1 Chinook Salmon .....	-13-
2.3.1.1 Snake River Fall Chinook .....	-13-
2.3.1.2 Lower Columbia River Chinook .....	-15-
2.3.2 Steelhead .....	-20-
2.3.2.1 Snake River Basin Steelhead .....	-21-
2.3.2.2 Upper Columbia River Steelhead .....	-31-
2.3.2.3 Middle Columbia River Steelhead .....	-35-
2.3.2.3 Lower Columbia River Steelhead .....	-36-
2.3.3 Chum Salmon .....	-38-
3.0 ENVIRONMENTAL BASELINE .....	-39-
3.1 Description of Action Area .....	-40-
3.2 Biological Requirements in Action Area .....	-40-
3.2.1 Essential Habitat Features in Action Area .....	-40-
3.2.2 Adequacy of Habitat Conditions .....	-41-
3.3 Factors Affecting Species' Environment in Action Area .....	-41-
3.3.1 Hydrosystem Effects .....	-41-
3.3.2 Habitat Effects .....	-42-
3.3.3 Hatchery Effects .....	-45-
3.3.4 Harvest Effects .....	-47-
3.3.4.1 Ocean Harvest .....	-47-
3.3.4.2 Columbia Basin Harvest .....	-48-

3.4	Natural Conditions .....	-48-
3.5	Expected Future Performance .....	-53-
4.0	EFFECTS OF THE ACTION .....	-53-
4.1	Effects on Critical Habitat and Essential Habitat Features .....	-54-
4.2	Factors to Be Considered .....	-54-
4.3	Effects of the Proposed Action .....	-55-
4.3.1	Chinook Salmon .....	-55-
4.3.2	Steelhead .....	-56-
4.3.3	Chum Salmon .....	-56-
5.0	CUMULATIVE EFFECTS .....	-57-
6.0	INTEGRATION AND SYNTHESIS OF EFFECTS .....	-58-
6.1	Chinook Salmon .....	-58-
6.1.1	Snake River Fall Chinook .....	-58-
6.1.2	Lower Columbia River Chinook .....	-61-
6.2	Steelhead .....	-64-
6.3	Chum Salmon .....	-69-
7.0	CONCLUSION .....	-70-
8.0	INCIDENTAL TAKE STATEMENT .....	-70-
8.1	Amount or Extent of Incidental Take Anticipated .....	-71-
8.1.1	Chinook Salmon .....	-71-
8.1.2	Steelhead .....	-71-
8.1.3	Chum Salmon .....	-72-
8.2	Effect of the Take .....	-72-
8.3	Reasonable and Prudent Measures .....	-72-
8.4	Terms and Conditions .....	-72-
9.0	CONSERVATION RECOMMENDATIONS .....	-73-
10.0	REINITIATION OF CONSULTATION .....	-76-
11.0	MAGNUSON-STEVENSON ACT ESSENTIAL FISH HABITAT CONSULTATION .....	-77-
11.1	Identification of Essential Fish Habitat .....	-78-
11.2	Proposed Action and Action Area .....	-78-
11.3	Effects of the Proposed Action .....	-78-
11.4	Conclusion .....	-78-
11.5	EFH Conservation Recommendation .....	-78-
11.6	Statutory Response Requirement .....	-79-
11.7	Consultation Renewal .....	-79-

12.0	REFERENCES .....	-80-
------	------------------	------

## INTRODUCTION

The National Marine Fisheries Service (NMFS) is required under section 7 of the Endangered Species Act (ESA) to conduct a consultation that considers the impacts of proposed fall season salmon fisheries on species listed under the ESA. This biological opinion considers the effects of fisheries proposed for the year 2002 in the Columbia River Basin (CRB) by the States of Oregon and Washington, the Nez Perce Tribe (NPT), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSR), and the Yakama Indian Nation (YIN) (hereafter referred to as “Parties”). Listed species in the action area that are potentially affected by the proposed fisheries include Snake River (SR) fall and Lower Columbia River (LCR) chinook and Columbia River (CR) chum salmon, and Upper Columbia River (UCR), SR, LCR, and Middle Columbia River (MCR) steelhead.

## CONSULTATION HISTORY

Fisheries in the CRB were managed subject to provisions of the Columbia River Fish Management Plan (CRFMP) from 1988 through 1998. The CRFMP was a stipulated agreement adopted by the Federal Court under the continuing jurisdiction of U.S. v Oregon. NMFS provided consultation under section 7 of the ESA on proposed fisheries in the Columbia Basin since 1992 when affected salmonids were first listed. The Technical Advisory Committee (TAC) of U.S. v Oregon routinely prepared biological assessments for proposed fisheries that were submitted to NMFS through the U.S. Fish and Wildlife Service (USFWS). The TAC biological assessments considered treaty Indian and non-Indian fisheries within the jurisdiction of the CRFMP (with the exception of Idaho State fisheries in the Snake River Basin (SRB), which were considered separately under section 10 of the ESA).

Fall season fisheries in the CR were managed from 1996-1998 under provisions of the 1996-1998 Management Agreement for Upper Columbia River Fall Chinook. The Management Agreement modified provisions of the CRFMP to include specific management provisions for the management of SR fall chinook. NMFS issued a Biological Opinion covering fall season fisheries under the terms of the three year agreement (NMFS 1996a). NMFS then reinitiated consultation in 1998 to consider additional management measures for the protection of newly listed steelhead species and issued a revised Opinion that covered the 1998 fall season fisheries (NMFS 1998).

The CRFMP expired on December 31, 1998, but was extended by court order through July 31, 1999. The Plan expired thereafter. The 1999 fall season fisheries were managed pursuant to the 1999 Management Agreement between the state, tribal and federal parties to U.S. v Oregon. The proposed state and tribal fisheries were considered through a section 7 consultation. The federal government’s participation in that agreement was the federal action that provided the necessary nexus for consultation.

The consultation processes for the 2000 and 2001 fisheries were similar. In both years the form of the consultation for the fall season fishery was initially unclear. At the outset there was no agreement among the parties regarding fall fisheries, particularly with respect to allocation. Absent an agreement or other recognizable federal action, there was no nexus for covering proposed state fisheries under section 7, and NMFS advised the states of Oregon and Washington that they should apply for a section 10 permit. Although the states disagreed with NMFS on the question of nexus for the state fisheries, they nonetheless submitted section 10 permit applications for consideration of their fall season fisheries (Greer and Koenings 2000a, Norman and Tweit 2001). The BIA initiated section 7 consultation behalf of the tribes for 2000 and 2001 by providing NMFS biological assessments regarding the tribes' proposed fall season fisheries (Jamison 2000, Overberg 2001).

Initially, the state and tribal fisheries were analyzed separately using the section 7 and 10 processes. However, prior to completion of the consultation, the U.S. v Oregon parties resolved outstanding issues and concluded annual agreements regarding management of the 2000 and 2001 fall season fisheries (U.S. v Oregon Parties 2000, 2001). As was the case in 1999, these agreements among the state, tribal, and federal parties provided a nexus for NMFS' consideration of the combined state and tribal fisheries through a single section 7 consultation. The states' permit applications and the tribes' biological assessments describe the respective proposed fisheries. The states and tribes subsequently requested that their initial proposals be considered as part of a joint action pursuant to the annual fall agreements, and provided updates where necessary to clarify the magnitude of impacts that would be associated with their now revised fishery proposals (Greer and Koenings 2000b).

In 2002, unlike the prior years, the parties concluded an agreement early-on regarding the 2002 fall season fisheries. The 2002 Management Agreement (U.S. v Oregon Parties 2002) among the state, tribal, and federal parties again provided a nexus for NMFS' consideration of the proposed fisheries which were described in a biological assessment prepared by TAC (LeFleur 2002).

## **BIOLOGICAL OPINION**

### **1.0 DESCRIPTION OF THE PROPOSED ACTION**

#### **1.1 Proposed Action**

The action considered in this Biological Opinion is the agreement of the action agencies with respect to the 2002 fall season fisheries in the CRB proposed by the Parties (LeFleur 2002). The non-Indian fisheries proposed by the states of Oregon and Washington extend from August 1, 2002 to December 31, 2002 in the CR mainstem from its mouth to Priest Rapids Dam and to Ice Harbor Dam on the SR. Non-Indian fisheries addressed in this opinion include mainstem sport fisheries for salmonids from Buoy 10 upstream to Priest Rapids Dam, commercial fisheries for salmon and sturgeon from the CR mouth to Bonneville Dam, sport sturgeon and warmwater fisheries from the CR mouth to Priest Rapids Dam, Wanapum tribal fisheries downstream from Priest Rapids Dam, and various fishery monitoring activities (Table 1). Methods of non-Indian

fishing include hook-line, drift gillnet and setline (which target sturgeon exclusively).

The treaty Indian fall season fisheries included in this biological assessment would occur between August 1, 2002, and December 31, 2002. The treaty Indian fall season fisheries include all mainstem CR fisheries between Bonneville Dam and McNary Dam (commonly known as Zone 6), all mainstem CR fisheries upstream of McNary Dam to Wanapum Dam (commonly known as the Hanford Reach Area), and all fisheries within tributaries above Bonneville Dam except for those in the SRB (Table 1).

Methods of treaty Indian fishing include dipnet, hoopnet, bagnet, hook-line and set gillnet. There is also the potential for sturgeon setline fisheries which target sturgeon exclusively. All of these fishing methods may be employed for ceremonial, subsistence and commercial harvest. In the past few years, commercial gillnet fishing has occurred from mid-August through early October. In some years, subsistence gillnet fisheries have been authorized by the tribes in October.

The states and tribes propose to manage their fisheries subject to various harvest rate caps for individual ESUs or ESU components. In some cases the parties presume that the fisheries will be managed up to the specified limit. In other cases there are differences between the harvest rate cap and the expected harvest rate. For example, SR fall chinook are considered the limiting stock, and fisheries are likely to be managed up to the 31.29% harvest rate limit. Alternatively, the states propose to manage their fisheries subject to a 2% harvest rate limit on natural-origin steelhead. However, the expectation is that the chinook limit will be reached before the steelhead limit is reached. The expected harvest rate on A-run steelhead for each of the ESUs is generally less than 2%. In discussing the effects of the action, a distinction is therefore made, where appropriate, between a proposed harvest rate cap and the expected harvest rate resulting from the proposed fishery. The ESU specific harvest rate limits are discussed in more detail in section 4 - Effects of the Action.

## **1.2 Action Area**

For purposes of this Biological Opinion, the action area encompasses the Columbia River from its mouth upstream to the Wanapum Dam, including its tributaries (with the exception of the Willamette River). The action area therefore includes portions of the states of Washington, Oregon, and Idaho.

## **2.0 STATUS OF SPECIES AND CRITICAL HABITAT**

Seven salmonid Evolutionary Significant Units (ESUs) listed under the ESA are present in the action area and are potentially affected by the proposed fisheries (Table 2). SR fall and LCR chinook salmon are listed as threatened; CR chum salmon is listed as threatened, UCR steelhead is listed as endangered; and SR, LCR, and MCR steelhead are listed as threatened.

As indicated in section 2.1 below critical habitat was previously designated for all of the potentially affected ESUs. However, for some of the ESUs the critical habitat designations were vacated and remanded to NMFS for new rule making pursuant to a May 2002 court order. In absence of a new rule designating critical habitat for those ESUs, this consultation will evaluate the effects of the proposed actions on the essential features of species' habitat to determine whether those actions are likely to jeopardize the species' continued existence.

<b>Table 1.</b> Columbia River non-Indian, non-treaty Indian fisheries proposed for 2002 and considered in this opinion.	
<b>NON-INDIAN FISHERIES</b>	
Non-Indian Commercial Fisheries	
	Mainstem Commercial Salmon/Sturgeon Fisheries Fall Commercial Fishery - Select Areas <i>Smelt Commercial Fishery/Test Fishery*</i> <i>Commercial anchovy and herring bait fishery*</i>
Non-Indian Recreational Fisheries	
	Mainstem Salmon/Steelhead Recreational Fishery Warmwater Recreational Fishery Columbia River Tributary Recreational Salmon and Steelhead Fisheries <i>Select Area Recreational fisheries*</i> <i>Sturgeon Recreational Fishery*</i>
Non-Indian Test/Assessment Fisheries	
	Sturgeon tagging stock assessment <i>Fall Selective Gear Test Fishery*</i>
Non-Treaty Indian Subsistence Fishery**	
	Wanapum Tribe Subsistence Fishery
<b>TREATY INDIAN FISHERIES</b>	
Zone 6 Fishery Hanford Reach Fishery Tributary fisheries	
	Little White Salmon River Klickitat River <i>Deschutes River *</i> John Day River Umatilla River Walla Walla River Yakima River <i>Snake River Basin *</i>
<i>*No anticipated impacts to ESA-listed salmonids</i>	



**Table 2.** Summary of salmonid species from the CRB listed under the Endangered Species Act by the NMFS. Those shown in bold are potentially affected by the proposed action.<sup>1</sup>

Species	Evolutionarily Significant Unit	Present Status	Federal Register Notice
Chinook Salmon ( <i>O. tshawytscha</i> )	<b>Snake River Fall</b> Snake River Spring/Summer <b>Lower Columbia River</b> Upper Willamette River Upper Columbia River Spring	Threatened Threatened Threatened Threatened Endangered	57 FR 14653 4/22/92 57 FR 14653 4/22/92 64 FR 14308 3/24/99 64 FR 14308 3/24/99 64 FR 14308 3/24/99
Chum Salmon ( <i>O. keta</i> )	<b>Columbia River</b>	Threatened	64 FR 14570 3/25/99
Sockeye Salmon ( <i>O. nerka</i> )	Snake River	Endangered	56 FR 58619 11/20/91
Steelhead ( <i>O. mykiss</i> )	<b>Upper Columbia River</b> <b>Snake River Basin</b> <b>Lower Columbia River</b> Upper Willamette River <b>Middle Columbia River</b>	Endangered Threatened Threatened Threatened Threatened	62 FR 43937 8/18/97 62 FR 43937 8/18/97 63 FR 13347 3/19/98 64 FR 14517 3/25/99 64 FR 14517 3/25/99

<sup>1</sup>Other ESUs are not affected because their run timing is such that they have passed through areas of proposed fisheries prior to the start of fishing on August 1st.

## 2.1 Species Descriptions and Critical Habitat Designations

### 2.1.1 Chinook Salmon

The SR fall chinook ESU includes all natural-origin populations of fall chinook in the mainstem SR and several tributaries including the Tucannon, Grande Ronde, Salmon, and Clearwater rivers. Fall chinook from the Lyons Ferry Hatchery are included in the ESU but are not listed. Critical habitat for the SR fall chinook salmon ESU was designated on December 28, 1993 (58 FR 68543).

The LCR chinook ESU includes all native populations from the mouth of the CR to the crest of the Cascade Range, excluding populations above Willamette Falls. Not included in this ESU are “stream-type” spring-run chinook salmon found in the Klickitat River (which are considered part of the MCR Spring-Run ESU) or the introduced Carson spring-chinook salmon strain. “Tule” fall chinook salmon in the Wind and Little White Salmon Rivers are included in this ESU, but not introduced “upriver bright” fall-chinook salmon populations in the Wind, White Salmon, and Klickitat Rivers. For the LCR chinook ESU, the Cowlitz, Kalama, Lewis, White Salmon, and Klickitat Rivers are the major river systems on the Washington side, and the Willamette and

Sandy Rivers are foremost on the Oregon side. The majority of this ESU is represented by fall-run fish and includes both north migrating tule-type stocks<sup>1</sup> and far-north migrating bright stocks<sup>2</sup>, but the few remaining spring stocks in the Lower Columbia are included as well. Several of the hatchery populations in the LCR are included in the ESU but none are listed. Critical habitat for the LCR chinook ESU was designated on February 16, 2000 (65 FR 7764), but was subsequently vacated by the May 2002 court order.

### **2.1.2 Steelhead**

The SR steelhead ESU includes all natural-origin populations of steelhead in the SRB of Southeast Washington, northeast Oregon, and Idaho. None of the hatchery stocks in the SRB are listed, but several are included in the ESU. Critical habitat for the SR steelhead ESU was designated on February 16, 2000 (65 FR 7764)), but was subsequently vacated by the May 2002 court order.

The UCR steelhead ESU includes all natural-origin populations of steelhead in the CRB between the Yakima River and the U.S./Canada Border. The Wells Hatchery stock is included among the listed populations. Critical habitat for the UCR steelhead ESU was designated on February 16, 2000 (65 FR 7764)), but was subsequently vacated by the May 2002 court order.

The MCR steelhead ESU includes all natural-origin populations in the CRB from above the Wind River in Washington and the Hood River in Oregon upstream to include the Yakima River in Washington. Steelhead of the SRB are not included in the MCR steelhead ESU. Both the Deschutes River and Umatilla River hatchery stocks are included in the ESU, but are not listed. Critical habitat for the MCR steelhead ESU was designated on February 16, 2000 (65 FR 7764)), but was subsequently vacated by the May 2002 court order.

The LCR steelhead ESU includes all natural-origin populations in tributaries to the CR between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon, inclusive. Excluded are steelhead in the upper Willamette River and steelhead from the Little and Big White Salmon Rivers, Washington, which are in the MCR ESU. None of the hatchery

---

<sup>1</sup>“Tules” spawn within a few weeks of river return. They are distinguished by their dark skin coloration and advanced state of maturation at the time of freshwater entry (WDF et al. 1993) and exhibit distinct secondary maturation characteristics (including resorbed scales and pronounced kype). Most tule populations return to production areas lower in the Columbia River drainage

<sup>2</sup>“Brights” are less mature at freshwater entry than tules, with a longer time interval between freshwater entry and spawning (Marshall et al. 1995). Brights return to areas throughout the basin, but are generally later returning and are primarily destined for areas higher in the drainage. Differences between tules and brights are consistent with genetic analysis (Myers et al. 1998).

stocks were included as part of the listed ESU. Critical habitat for the LCR steelhead ESU was designated on February 16, 2000 (65 FR 7764)), but was subsequently vacated by the May 2002 court order.

### **2.1.3 Chum Salmon**

The CR chum ESU includes all natural-origin populations in the LCR. Chum salmon from the Grays River Hatchery and Cowlitz River Hatchery are considered part of the ESU, but are not listed. Critical habitat for the CR chum ESU was designated on February 16, 2000 (65 FR 7764)), but was subsequently vacated by the May 2002 court order.

## **2.2 General Life History**

General life history information is presented below for chinook salmon, west coast steelhead, and chum salmon. More specific information regarding species status and recent population trends are provided separately for each ESU in the following section.

### **2.2.1 Chinook Salmon**

Chinook salmon are the largest of the Pacific salmon. The species' distribution historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Additionally, chinook salmon have been reported in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Of the Pacific salmon, chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for chinook salmon, 7 total ages with 3 possible freshwater ages. This level of complexity is roughly comparable to sockeye salmon (*O. nerka*), although sockeye salmon have a more extended freshwater residence period and utilize different freshwater habitats (Miller and Brannon 1982, Burgner 1991). Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" chinook salmon migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of chinook salmon. This racial approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of chinook salmon populations. For the purposes of this Opinion, those chinook salmon (spring and summer runs) that spawn upriver from the Cascade crest are generally "stream-type"; those which spawn downriver of the Cascade Crest (including in the Willamette River) are generally "ocean-type".

The generalized life history of Pacific salmon involves incubation, hatching, and emergence in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of maturation and spawning. Juvenile rearing in freshwater can be minimal or extended. Additionally, some male chinook salmon mature in freshwater, thereby foregoing emigration to the ocean. The timing and duration of each of these stages is related to

genetic and environmental determinants and their interactions to varying degrees. Salmon exhibit a high degree of variability in life-history traits; however, there is considerable debate as to what degree this variability is the result of local adaptation or the general plasticity of the salmonid genome (Ricker 1972, Healey 1991, Taylor 1991). More detailed descriptions of the key features of chinook salmon life history can be found in Myers, et al. (1998) and Healey (1991).

### **2.2.2 Steelhead**

Biologically, steelhead can be divided into two basic run-types, based on the state of sexual maturity at the time of river entry and duration of spawning migration (Burgner et al. 1992). The stream-maturing type, or summer steelhead, enters fresh water in a sexually immature condition and requires several months in freshwater to mature and spawn. The ocean-maturing type, or winter steelhead, enters fresh water with well-developed gonads and spawns shortly after river entry (August 9, 1996, 61 FR 41542; Barnhart 1986). Variations in migration timing exist between populations. Some river basins have both summer and winter steelhead, while others only have one run-type.

Summer steelhead enter fresh water between May and October in the Pacific Northwest (Busby et al. 1996; Nickelson et al. 1992). They require cool, deep holding pools during summer and fall, prior to spawning (Nickelson et al. 1992). They migrate inland toward spawning areas, overwinter in the larger rivers, resume migration in early spring to natal streams, and then spawn (Meehan and Bjornn 1991; Nickelson et al. 1992).

Winter steelhead enter fresh water between November and April in the Pacific Northwest (Busby et al. 1996; Nickelson et al. 1992), migrate to spawning areas, and then spawn in late winter or spring (Nickelson et al. 1992). Some adults, however, do not enter coastal streams until spring, just before spawning (Meehan and Bjornn 1991).

Steelhead typically spawn between December and June (Bell 1991), and there is a high degree of overlap in spawn timing between populations regardless of run type (Busby et al. 1996). Difficult field conditions at that time of year and the remoteness of spawning grounds contribute to the relative lack of specific information on steelhead spawning.

Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death. However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (August 9, 1996, 61 FR 41542; Nickelson et al. 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby et al. 1996). Multiple spawnings for steelhead range from 3-20% of runs in Oregon coastal streams.

Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may be used for spawning (Barnhart 1986; Everest 1973). Steelhead enter streams and arrive at spawning grounds weeks or even months before they spawn and are vulnerable to disturbance and predation. Cover, in the form of overhanging vegetation, undercut

banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water, turbulence, and turbidity (Giger 1973) are required to reduce disturbance and predation of spawning steelhead. It appears that summer steelhead occur where habitat is not fully utilized by winter steelhead; summer steelhead usually spawn further upstream than winter steelhead (Withler 1966; Behnke 1992).

Depending on water temperature, steelhead eggs may incubate for 1.5 to 4 months (August 9, 1996, 61 FR 41542) before hatching. Summer rearing takes place primarily in the faster parts of pools, although young-of-the-year are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small wood. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson et al. 1992).

Juveniles rear in fresh water from one to four years, then migrate to the ocean as smolts (August 9, 1996, 61 FR 41542). Winter steelhead populations generally smolt after two years in fresh water (Busby et al. 1996).

Steelhead typically reside in marine waters for two or three years prior to returning to their natal stream to spawn as four- or five-year olds (August 9, 1996, 61 FR 41542). Populations in Oregon and California have higher frequencies of age-1-ocean steelhead than populations to the north, but age-2-ocean steelhead generally remain dominant (Busby et al. 1996). Age structure appears to be similar to other west coast steelhead, dominated by four-year-old spawners (Busby et al. 1996).

Based on purse seine catch, juvenile steelhead tend to migrate directly offshore during their first summer from whatever point they enter the ocean rather than migrating along the coastal belt as do salmon. During fall and winter, juveniles move southward and eastward (Hartt and Dell 1986). Oregon steelhead tend to be north-migrating (Nicholas and Hankin 1988; Pearcy et al. 1990; Pearcy 1992).

### **2.2.3 Chum Salmon**

Historically, chum salmon were distributed throughout the coastal regions of western Canada and the United States, as far south as Monterey Bay, California. Presently, major spawning populations are found only as far south as Tillamook Bay on the northern Oregon coast.

Chum salmon (*Oncorhynchus keta*) are semelparous, spawn primarily in freshwater and, apparently, exhibit obligatory anadromy (there are no recorded landlocked or naturalized freshwater populations) (Randall et al. 1987). Chum salmon spend more of their life history in marine waters than other Pacific salmonids. Chum salmon, like pink salmon, usually spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to nearly 100 km from the sea. Juveniles outmigrate to seawater almost immediately after emerging from the gravel that covers their redds (Salo 1991). This

ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (e.g., coastal cutthroat trout, steelhead, coho salmon, and most types of chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

## **2.3 Population Dynamics and Distribution**

In its review of population status and the effects of the proposed action on the listed salmonid ESUs in the Columbia River basin, NMFS is using developing science from several areas including the Cumulative Risk Initiative (CRI), Viable Salmonid Populations (VSP) paper, and Recovery Exploitation Rate (RER) analysis. Each of these are described briefly below to provide context prior to their application in the subsequent ESU-specific status discussions.

### Cumulative Risk Initiative

To determine the conservation status of the listed ESUs, NMFS is relying increasingly on the evolving scientific analysis contained in the CRI, which is an ongoing effort of the Northwest Fisheries Science Center (NWFSC 2000, NMFS 2000a). The CRI is designed to provide a standardized assessment of extinction risks and the magnitude of improvements required to mitigate these risks. The CRI provides an analytical structure that begins to allow evaluation of the potential effects of management actions aimed at different life stages or sources of mortality. In general, the CRI therefore provides a tool to assess the degree to which survival improvements in a particular sector can be combined with expected improvements in other sectors to provide the necessary overall improvements required for survival and recovery. The CRI analysis was used extensively in the Federal Columbia River Power System (FCRPS) biological opinion and the Basin Wide Recovery Strategy (referred to as the “All-H” paper throughout this biological opinion) to help resolve critical questions regarding the magnitude of required survival improvements and how those survival improvements may be allocated among the various H’s including harvest (NMFS 2000a).

The CRI constructs population models for each species and assesses the risk of extinction for populations and/or for ESUs (depending on the data available). To assess the risk of extinction, the CRI examines the population growth rate from 1980 through the most recent returns, and the year-to-year variability of the population’s productivity.

For both ESUs and individual index stocks the CRI estimates average annual rate of population change or “lambda”. Lambda, which incorporates year-to-year variability, is the best summary statistic of how rapidly a population is growing or shrinking. A lambda less than 1.0 means the population is declining; a lambda greater than 1.0 means the population is increasing.

By combining lambda with estimates of environmental variability it is possible to calculate “extinction risk metrics.” The CRI assesses the risk of *absolute* extinction, that is, one or no fish for five consecutive years. The analysis also reports the risk of 90% decline in abundance. All extinction metrics are calculated on a 24- and 100-year time frame. For index stocks, where the data represent entire population counts, extinction risks are expressed in terms of the probability of an adult population falling to only one spawner. For ESUs we calculate extinction metrics as the probability of a 90% decline after 24 years and after 100 years, because it is unlikely that entire ESUs have been accurately counted.

The models use survival for each life-stage, which allows a closer examination of the impacts of the various H’s (Hydro, Habitat, Hatcheries and Harvest) on population growth and on corresponding extinction risk. The models can help identify the life stages at which changes in survival will yield the largest impact on population growth rates. By running numerical experiments, the modelers can help put in perspective the impact of a particular activity, such as harvest, on the likelihood of extinction for a given population or ESU.

The CRI models project risks of extinction *if all factors remain the same as they were during the base years of the analysis*. NMFS recognizes that many actions have been taken to improve the survival of these ESUs in recent years, and also recognizes that the base period arguably represents a particularly bad time for ocean survival of most ESUs. In the All-H paper and the FCRPS biological opinion, NMFS has taken into account the management improvements that have been made, as well as the potential benefits from improved ocean conditions of the past few years.

Because the ESA is directed at the conservation of naturally reproducing species and their habitats, NMFS uses the CRI models to determine the risk of extinction of the naturally spawning populations and ESUs. A major source of uncertainty in these analyses is whether and to what extent hatchery-spawned fish contribute to the next generation (certain assumptions must therefore be made about the spawning success of these adults). The uncertainties related to hatchery fish greatly affect estimates of productivity and in turn estimates of extinction risk and the magnitude of survival improvements that may be required. Low and high estimates of lambda were therefore reported based on the assumptions that hatchery-origin fish either contribute nothing to natural production or are equally successful as the natural-origin spawners. The relative productivity of hatchery fish almost certainly varies between populations and falls between the “all or nothing” assumptions.

Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period that varies between subbasin populations. Population trends are projected under the assumption that all conditions will stay the same into the future.

#### Viable Salmonid Population

Another approach to assessing the status of an ESU and its component populations that is being developed by NMFS is described in a paper related to Viable Salmonid Populations (McElhany et. al. 2000). This paper provides guidance for determining the conservation status of

populations and ESUs that can be used in ESA-related processes. In this opinion, we rely on VSP guidance in describing the population or stock structure of each ESU and the related effects of the action.

A population is defined in the VSP paper as a group of fish of the same species spawning in a particular lake or stream (or portion thereof) at a particular season which to a substantial degree do not interbreed with fish from any other group spawning in a different place or in the same place at a different season. Because populations as defined here are relatively isolated, it is biologically meaningful to evaluate the risk of extinction of one population independently from any other. Some ESUs may have only one population while others will have many.

The task of identifying populations within an ESU will require making judgments based on the available information. Information regarding the geography, ecology, and genetics of the ESU are relevant to this determination. This is a task that will generally be taken up as part of the recovery planning process. Recovery planning is just now getting underway in the Columbia River Basin. The Willamette/Lower Columbia River Technical Review Team (TRT) has provided preliminary recommendations regarding the historic population structure for the LCR chinook, LCR steelhead, and Columbia River chum ESUs (Myers et al. 2002). The TRT for the Interior Columbia Basin ESUs is not as far along, but NMFS has provided interim guidance regarding geographic spawning aggregations for SR fall chinook, and SR, UCR, and MCR steelhead (Lohn 2002). It is appropriate in this opinion to consider the potential diversity of each ESU and the status of the component stocks to the degree possible.

The VSP paper also provides guidance regarding parameters that can be used for evaluating population status including abundance, productivity, spatial structure, and diversity. In this opinion we consider particularly the guidance related to abundance. The paper provides several rules of thumb that are intended to serve as guidelines for setting population specific thresholds (McElhany et al. 2000). The guidance relates to defining both "viable" populations levels and "critical" abundance levels. Although there are still no specific recommendations regarding threshold abundance levels for the effected ESUs, the concepts are developed in the opinion to the degree possible for evaluating population status and the related effect of the action. NMFS has recently provided interim abundance targets for ESUs in the Interior Columbia Basin (Lohn 2002) and these are considered where appropriate.

#### Recovery Exploitation Rate

In general and where possible, NMFS has sought to evaluate the proposed fisheries using biologically-based measures of the total exploitation rate that occurred across the full range of the species. Toward this end, NMFS has developed an approach for defining target ERs that can be related directly to the regulatory definition of jeopardy. One product of this approach is a rebuilding exploitation rate (RER) that can be calculated for representative stocks within ESUs (NMFS 2000d). NMFS can then evaluate proposed fisheries, at least in part, by comparing the RERs to stock-specific ERs that are anticipated as a result of the proposed fisheries including those outside the action area. This method has been developed and applied primarily with respect to Puget Sound chinook stocks (see for example NMFS 2001a). However, an RER has been developed and used in recent years for evaluating harvest related mortality for the



Coweeman stock in the LCR ESU. The RER approach was used as part of the assessment of the Pacific Salmon Treaty in 1999 (NMFS 1999c), the 2000 opinion on PFMC fisheries (NMFS 2000c) and more recently for the application of take limits for Puget Sound chinook under the 4(d) Rule (NMFS 2001a). NMFS recently updated their RER analysis for the Coweeman stock which is part of the LCR chinook ESU, and used the updated RER for evaluating ocean fisheries in 2002 (Lohn and McInnis 2002). Because of the comprehensive nature of the Coweeman RER standard and close relationship between ocean and inriver fisheries, the Parties proposed to use it for evaluating inriver fisheries as well.

### **2.3.1 Chinook Salmon**

#### **2.3.1.1 Snake River Fall Chinook**

The spawning grounds between Huntington (RM 328) and Auger Falls (RM 607) were historically the most important for this species. Only limited spawning activity was reported downstream from RM 273 (Waples, et al. 1991), about one mile upstream of Oxbow Dam. Since then, irrigation and hydropower projects on the mainstem SR have blocked access to or inundated much of this habitat—causing the fish to seek out less-preferable spawning grounds wherever they are available. Natural fall chinook salmon spawning now occurs primarily in the SR below Hells Canyon Dam and the lower reaches of the Clearwater, Grand Ronde, Salmon, and Tucannon Rivers.

Adult SR fall chinook salmon enter the CR in July and migrate into the SR from August through October. Fall chinook salmon generally spawn from October through November and fry emerge from March through April. Downstream migration generally begins within several weeks of emergence (Becker 1970, Allen and Meekin 1973), and juveniles rear in backwaters and shallow water areas through mid-summer prior to smolting and migrating to the ocean—thus they exhibit an “ocean” type juvenile history. Once in the ocean, they spend one to four years (though usually, three) before beginning their spawning migration. Fall returns in the SR system are typically dominated by four-year-old fish. For detailed information on the SR fall chinook salmon, see NMFS (1991) and June 27, 1991, 56 FR 29542.

No reliable estimates of historical abundance are available, but because of their dependence on mainstem habitat for spawning, fall chinook have probably been impacted to a greater extent by the development of irrigation and hydroelectric projects than any other species of salmon. It has been estimated that the mean number of adult SR fall chinook salmon declined from 72,000 in the 1930s and 1940s to 29,000 during the 1950s. In spite of this, the SR remained the most important natural production area for fall chinook in the entire CRB through the 1950s. The number of adults counted at the uppermost SR mainstem dams averaged 12,720 total spawners from 1964 to 1968, 3,416 spawners from 1969 to 1974, and 610 spawners from 1975 to 1980 (Waples, et al. 1991).

Counts of adult fish of natural-origin continued to decline through the 1980s reaching a low of 78 individuals in 1990 (Table 3). Through 2000 the return of natural-origin fish to Lower Granite Dam (LGD) was variable, but generally increasing reaching a recent year high of 905 in

1999. In 2001, there was a several fold increase in the escapement past LGD. The total escapement past LGD was nearly 13,000 including almost 6,800 natural-origin fish and 6,000 hatchery-origin fish (Table 3). For comparison, the second highest return of natural-origin fish was 1,000 which occurred in 1975.

These returns can be compared to the previously identified lower abundance threshold of 300 and the recovery escapement goal of 2,500 which are the kinds of benchmarks suggested in the Viable Salmonid Populations paper (McElhany et al. 1999) for evaluating population status. The lower threshold is considered indicative of increased relative risk to a population in the sense that the further and longer a population is below the threshold the greater the risk; it was clearly not characterized as a “redline” below which a population must not go (BRWG 1994). The recovery standard that was initially identified in the 1995 BiOp for SR fall chinook was a population of at least 2,500 naturally produced spawners (to be calculated as an eight year geometric mean) in the lower SR and its tributaries. NMFS has recently reiterated its recommendation of the 2,500 fish as an interim abundance target for SR fall chinook (Lohn 2002). The LGD counts can not be compared directly to the natural spawner escapement objective since it is also necessary to account for adults which may fall back below the dam after counting and prespawning mortality. A preliminary estimate suggested that a LGD count of 4,300 would be necessary to meet the 2,500 fish escapement goal (NMFS 1995). Until 2001 escapements were generally well below the goal, but were also consistently above the lower abundance threshold and generally increasing. Returns of natural-origin fish in 2001 were well above goal with several thousand additional supplementation fish passing above LGD that will also contribute to natural spawning.

A further consideration regarding the status of SR fall chinook is the existence of the Lyons Ferry Hatchery stock which is considered part of the ESU. Returns to the hatchery have increased steadily since the program began in 1990 from a few hundred fish in the early years to nearly 2,300 fish in 2001. In recent years supplementation efforts designed to accelerate rebuilding were initiated beginning with smolt outplants from the 1995 brood year. The supplementation program has been scaled up over the last several years to provide both fingerling and yearling outplants above LGD that are acclimated and released in areas above LGD with an immediate objective of increasing the number of natural-origin spawners. The return of adults to LGD from the supplementation program has increased from 479 in 1998 to over 5,000 in 2001 (this is in addition to the adults returning from natural production, see Table 3) with the immediate prospects for equal or greater returns in the future.

The existence of the Lyons Ferry program has been an important consideration in evaluating the status of the ESU since it reduces the short-term risk of extinction by providing a reserve of fish from the ESU. The return of fish from the supplementation program is not a substitute for recovery which depends on the return of self-sustaining populations in the wild. However, supplementation can be used to mitigate the short-term risk of extinction by boosting the initial abundance of spawners while other actions are taken to increase the productivity of the system to the point where the population is self-sustaining and supplementation is no longer required.

For the SR fall chinook salmon ESU as a whole, NMFS estimates that the median population growth rate ( $\lambda$ ) over the base period<sup>3</sup> ranges from 0.94 to 0.86 (Table 4), decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000a). NMFS has also estimated the risk of absolute extinction for the aggregate SR fall chinook salmon population, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years is 0.40 (Table B-5 in McClure et al. 2000a). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is 1.00 (Table B-6 in McClure et al. 2000a).

### **2.3.1.2 Lower Columbia River Chinook**

The LCR chinook ESU includes spring stocks and fall tule and bright components. Spring-run chinook salmon on the LCR, like those from coastal stocks, enter freshwater in March and April well in advance of spawning in August and September. The spring component of the LCR chinook ESU will not be affected by the proposed fall season fisheries.

Fall chinook predominate the LCR salmon runs. Fall chinook return to the river in mid-August and spawn within a few weeks (WDF and WDW 1993, Kostow 1995). The majority of fall-run chinook salmon emigrate to the marine environment as subyearlings (Reimers and Loeffel 1967, Howell et al. 1985, WDF and WDW 1993). A portion of returning adults whose scales indicate a yearling smolt migration may be the result of extended hatchery-rearing programs rather than of natural, volitional yearling emigration. It is also possible that modifications in the river environment may have altered the duration of freshwater residence. Adults return to tributaries in the LCR at 3 and 4 years of age for fall-run fish and 4 to 5 years of age for spring-run fish. This may be related to the predominance of yearling smolts among spring-run stocks. Marine coded-wire-tag recoveries for LCR stocks tend to occur off the British Columbia and Washington coasts, though a small proportion of the tags are recovered as far north as Alaska.

---

<sup>3</sup>Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1996 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

**Table 3. Escapement and Stock Composition of Fall Chinook at Lower Granite Dam**

Year	L. Granite Count	Marked Fish to Lyons Ferry Hatch.	L. Granite Dam Escapement	Stock Comp. of L. Granite Escapement		
				Naturally Spawned	Snake R.	Non-Snake R.
1975	1000		1000	1000		
1976	470		470	470		
1977	600		600	600		
1978	640		640	640		
1979	500		500	500		
1980	450		450	450		
1981	340		340	340		
1982	720		720	720		
1983	540		540	428	112	
1984	640		640	324	310	6
1985	691		691	438	241	12
1986	784		784	449	325	10
1987	951		951	253	644	54
1988	627		627	368	201	58
1989	706		706	295	206	205
1990	385	50	335	78	174	83
1991	630	40	590	318	202	70
1992	855	187	668	549	100	19
1993	1170	218	952	742	43	167
1994	791	185	606	406	20	180
1995	1067	430	637	350	1	286
1996	1308	389	919	639	74	206
1997	1451	444	1007	797	20	190
1998	1909	947	962	306	479	177
1999	3381	1519	1862	905	882	75
2000	3830	1372	2458	857	1278	323
2001*	15042	2289	12753	6783	5071	900

\* Preliminary (Sands 2002)

Table 4. Annual rate of population change ( $\lambda$ ), and risk of extinction (1 fish/generation) and risk of 90% decline in 24 and 100 years. The range of reported values assumes that natural spawning hatchery-origin fish either do not contribute to natural production or are as productive as natural-origin spawners. This analysis assumes that all factors remain the same as they were during the base years analyzed - generally 1980-1994

	$\lambda$	Risk of extinction		Probability of 90% decrease in stock abundance	
		24 yrs	100 yrs	24 yrs	100 yrs
<b>FALL CHINOOK</b>					
<b>Snake River fall chinook</b> <sup>1</sup>	0.938 - 0.859	0.000 - 0.000 <sup>2</sup>	0.400 - 1.000 <sup>2</sup>	0.244 - 0.995	0.964 - 1.00
<b>Lower Columbia River fall chinook</b> <sup>1</sup>	0.984 - 0.878	-	-	0.124 - 0.675	0.417 - 0.998
East Fork Lewis River (tule) chinook <sup>2</sup>	0.992 - 0.992	-	-	0.000 - 0.000	0.140 - 0.140
North Fork Lewis River (bright) <sup>2</sup> chinook	0.991 - 0.969	-	-	0.020 - 0.060	0.250 - 0.650
Sandy River (bright) chinook <sup>2</sup>	0.984 - 0.976	0.000 - 0.000	0.000 - 0.000	0.000 - 0.000	0.280 - 0.530
<b>CHUM SALMON</b>					
<b>Lower Columbia River Chum</b> <sup>1</sup>	1.035	-	-	0.000 - 0.000	0.000 - 0.000
<b>STEELHEAD</b>					
<b>Snake River Basin steelhead</b> <sup>1</sup>	0.910 - 0.699	-	-	0.476 - 1.000	1.000 - 1.000
A-run	0.925 - 0.718	0.000 - 0.000	0.010 - 1.000	0.200 - 1.000	1.000 - 1.000
B-run	0.892 - 0.726	0.000 - 0.000	0.930 - 1.000	0.730 - 1.000	1.000 - 1.000
<b>Upper Columbia River steelhead</b> <sup>1</sup>	0.941 - 0.662	0.000 - 0.870	0.250 - 1.000	0.194 - 1.000	0.970 - 1.000
<b>Middle Columbia River steelhead</b> <sup>1</sup>	0.882 - 0.753	-	-	1.000 - 1.000	1.000 - 1.000
Deschutes river summer steelhead <sup>2</sup>	0.864 - 0.748	0.000 - 0.000	1.000 - 1.000	1.000 - 1.000	1.000 - 1.000
Warm Springs summer steelhead <sup>2</sup>	0.907 - 0.907	0.000 - 0.000	0.920 - 0.920	0.520 - 0.520	1.000 - 1.000
Umatilla River summer steelhead <sup>2</sup>	0.895 - 0.904	0.000 - 0.000	0.910 - 0.910	0.910 - 0.640	1.000 - 1.000
Yakima River summer steelhead <sup>2</sup>	1.045 - 1.008	0.000 - 0.000	0.000 - 0.000	0.000 - 0.000	0.000 - 0.000
<b>Lower Columbia River steelhead</b> <sup>1</sup>	0.975 - 0.777	-	-	0.000 - 1.000	0.956 - 1.000
Clackamas River summer steelhead <sup>2</sup>	0.894 - 0.708	0.000 - 0.050	1.000 - 1.000	0.770 - 1.000	1.000 - 1.000
Kalama River summer steelhead <sup>2</sup>	1.035 - 0.741	0.000 - 0.000	0.000 - 1.000	0.000 - 1.000	0.000 - 1.000

<sup>1</sup> From Table B-2a and B-2b. Cumulative Risk Initiative. April 7, 2000, appendix tables updated September 2000 (McClure et al. 2000a).

<sup>2</sup> From Table B-5 and B-6. Cumulative Risk Initiative. April 7, 2000, appendix tables updated September 2000 (McClure et al. 2000a).

There are no reliable estimates of historic abundance for this ESU, but it is generally agreed that there have been vast reductions in natural production over the last century. Recent abundance of spawners includes a 5-year average of 28,000 natural spawners (1997-2001) with an additional escapement of 23,300 fish to the hatcheries (PFMC 2002b). About two-thirds of the natural spawners were presumably first-generation hatchery strays.

All basins in the region are affected to varying degrees by habitat degradation. Major habitat problems are related primarily to blockages, forest practices, urbanization in the Portland and Vancouver areas, and agriculture in flood plains and low-gradient tributaries. Substantial chinook salmon spawning habitat has been blocked (or passage substantially impaired) in the Cowlitz (Mayfield Dam 1963, RKm 84), Lewis (Merwin Dam 1931, RKm 31), Clackamas (North Fork Dam 1958, RKm 50), Hood (Powerdale Dam 1929, RKm 7), and Sandy (Marmot Dam 1912, RKm 48; Bull Run River dams in the early 1900s) rivers (WDF and WDW 1993, Kostow 1995).

Hatchery programs to enhance chinook salmon fisheries in the LCR began in the 1870s, expanded rapidly, and have continued throughout this century. Although the majority of the stocks have come from within this ESU, over 200 million fish from outside the ESU have been released since 1930. Available evidence indicates a pervasive influence of hatchery fish on natural populations throughout this ESU, including both spring- and fall-run populations (Howell et al. 1985, Marshall et al. 1995). In addition, the exchange of eggs between hatcheries in this ESU has led to the extensive genetic homogenization of hatchery stocks (Utter et al. 1989).

Hatchery production in the lower Columbia has been reduced substantially in recent years largely due to budget cuts. Releases of tule fall chinook in the lower Columbia have been reduced by about half since the mid-90s. Hatchery production programs in the lower Columbia and throughout the basin are now the subject of an ongoing consultation which should address, at least in the long-term, the adverse affects of hatchery practices on the ESU.

There are four self-sustaining natural populations of tule chinook in the LCR (Coweeman, East Fork Lewis, Clackamas, and Sandy) that are not substantially influenced by hatchery strays. These are all relatively small stocks. The average escapement on the Coweemen over the last five and ten years have been about 460 and 650, respectively, compared to an interim escapement goal of 1,000. These averages have been influenced substantially by the record escapements observed in 1996 and 1997 which ranged from 1,300 to 2,100 fish. From 1998 to 2000 escapements averaged about 120, but compare to escapements observed through much of the data record since 1964. The escapement in 2001 was over 600. The return of earlier timed tules to the East Fork Lewis has been relatively stable and averaged about 160 over the last five years compared to an escapement goal in this relatively small system of 300. The escapement in 2001 was over 300.

The tule stock in the Clackamas was apparently reestablished after it was largely eliminated from in-basin hatchery production that took place between 1952 and 1981 (Myers et al. 2002). There is also some question whether the tule run in the Sandy was native or introduced from hatchery production (Myers et al. 2002). There are currently no goals for the Clackamas or Sandy where

observed escapements have averaged about 50 and 160, respectfully in recent years. There have been no releases of hatchery fall chinook in the Clackamas since 1981 or the Sandy since 1977 and there are apparently few hatchery strays in these systems. There is also some natural spawning of tule fall chinook in the Wind, Little White Salmon, and Hood rivers, tributaries above Bonneville Dam. Although there may be some natural production in these systems, the spawning results primarily from hatchery-origin strays.

The LCR bright stocks are one of the few healthy natural chinook stocks in the CRB. Escapement to the North Fork Lewis River has exceed its escapement goal of 5,700 by a substantial margin every year since 1980 with a recent five year average escapement of 7,200. The escapement in 1999 was about 2,600, substantially below goal for the first time in 20 years or more. The escapements in 2000 and 2001 were 8,700 and 11,300 and thus again well above the escapement goal. The low return in 1999 has been attributed to severe flooding that occurred in 1995 and 1996 and was an apparent aberration.

There are two smaller groups of late-spawning LCR brights in the Sandy and East Fork Lewis rivers. Myers et al. (2002) recently concluded that the North Fork and East Fork Lewis River bright stocks were likely part of the same demographically independent population (DIP), and that they were closely related genetically to the Sandy River bright DIP. Escapements to the East Fork have averaged only about 130 over the last five years, but have been stable for at least the last ten years. Escapement in the East Fork in 2001 was over 200 adults. Average run sizes in the Sandy have averaged about 900 over the last ten years and 800 over the last five years. Lower escapements in the last two years may again be related to the 1995 and 1996 floods.

For the LCR chinook salmon ESU as a whole, NMFS estimates that the median population growth rate ( $\lambda$ ) over the base period <sup>4</sup> ranges from 0.98 to 0.88 (Table 4), decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000a). NMFS estimated the risk of absolute extinction for nine spawning aggregations<sup>5</sup>, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years ranges from zero for the Sandy River late run and Big Creek to 1.00 for Mill Creek (Table B-5 in McClure et al. 2000a). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is  $\geq 0.99$  for all but one of the nine spawning aggregations (zero for the Sandy River late run; Table B-6 in McClure et al. 2000a).

---

<sup>4</sup>Estimates of median population growth rate, risk of extinction, and likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1997 adult returns for most spawning aggregations. Population trends are projected under the assumption that all conditions will stay the same into the future.

<sup>5</sup>McClure et al. (2000b) have calculated population trend parameters for additional LCR chinook salmon stocks.

### 2.3.2 Steelhead

Steelhead stocks in the Columbia Basin have traditionally been distinguished as summer or winter-run stocks based on state of sexual maturity and time of river entry. All native fish returning to the Upper Willamette have a late winter-run return timing. Steelhead returning to the LCR are primarily winter-run fish while those returning to the MCR are primarily summer-run fish. All steelhead returning to the UCR and SR ESUs are considered summer-run steelhead. The return timing of winter steelhead to Bonneville Dam is between November 1 and March 31 with fish return to lower river tributaries during the same time frame. Winter-run fish returning to the Upper Willamette, LCR, and MCR ESUs are therefore largely unaffected by the proposed fall season fisheries which occur primarily from August through October.

Summer-run steelhead are divided further as A-run and B-run steelhead based on size and age differences and run timing. Hatchery and natural-origin stocks can be readily distinguished based on scale patterns or the adipose fin clip that is applied to virtually all hatchery-origin fish in the Columbia Basin. ESU designations, based in part on genetic affinities, do not correspond with these traditional stock divisions. As indicated above, some of the ESUs are a mix of summer and winter-run fish. All B-run steelhead return to the Snake River, but the Snake has A-run steelhead too which are all part of the SR ESU. Because of past practice, management data bases are aligned with these more traditional designations. Only in the last couple of years in response to recent listings have managers sought to assess harvest mortality by ESU or looked at other methods that allow different or finer levels of stock resolutions. The transition in assessment techniques is underway, but is not yet complete. Initial efforts using Genetic Stock Identification (GSI) techniques have been promising, but will require at least another year or two of assessment and development before it can be considered for use as a management alternative.

Prior to the 1999 fall season, TAC completed a review of information related to the biology and harvest of steelhead in the fall season fisheries with particular emphasis on alternative methods for measuring harvest related mortality. Based on this review, and assuming that there is an intention to manage specifically for the more sensitive components of the composite of wild steelhead in the basin, TAC recommended that steelhead mortality in fall season fisheries be assessed using a simplified method that differentiates between hatchery and wild fish and then further distinguishes based on length between small and large fish using a 77.5 cm threshold. This would replace the date and length methods that were used previously to distinguish between A and B-run steelhead (TAC 1999). The smaller summer run fish are all considered A-run steelhead and these too must be allocated among the various steelhead ESUs. At this point this is done using average proportional run sizes from the TAC run reconstruction data base.

This revised method is intended to resolve long standing concerns and debate about the date and length methods that were used previously to differentiate between A and B-run steelhead both in terms of run size and catch accounting. The method is an improvement in that it requires fewer assumptions and relies on a physical property (i.e., fish length) that can be mapped directly back to the populations of greatest concern. As discussed below, B-run steelhead are at risk because of their current depressed status. Upon review TAC confirmed the prior observation that the fish returning to the traditional B-run tributaries were predominately large fish (defined as greater



than 77.5 cm). These larger fish are more vulnerable to the fall season fisheries because their large size makes them more susceptible to capture in gillnets and because their timing is coincident with that of the upriver chinook that are being targeted. A management system that focuses on large fish therefore also properly focuses on the most vulnerable component of the run. Small fish benefit from this management approach too as they are subject to lower harvest rates due to their smaller size and earlier timing.

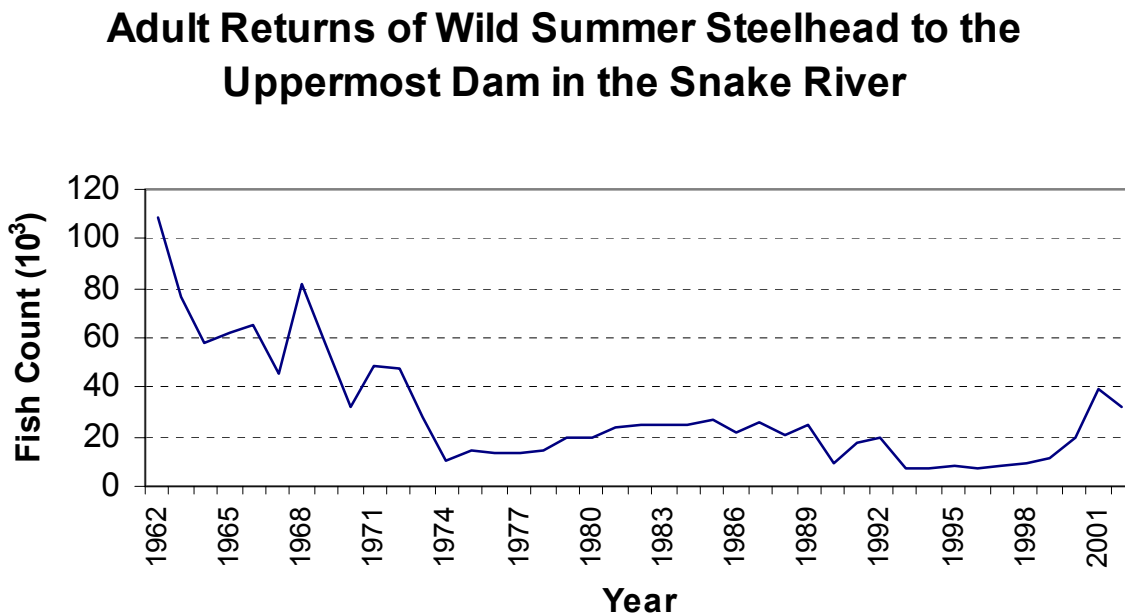
#### **2.3.2.1 Snake River Basin Steelhead**

The longest consistent indicator of Snake Basin steelhead abundance is based on counts of natural-origin steelhead at the uppermost dam on the lower Snake River. Abundance of natural-origin summer steelhead at the uppermost dam on the SR has declined generally until quite recently. The 4-year average count of steelhead at the uppermost dam was 58,300 beginning in 1964 compared to an average of 12,000 for the period ending in 1999. The general pattern has included a sharp decline in abundance in the early 1970's, modest rebuilding from the mid-1970's through the 1980's, and second period of decline during the much of decade of the 1990's (Figure 1). For the last two years the LGD counts have been substantially higher with counts of wild steelhead in 2000 and 2001 of 20,000 and 39,900. The count of wild fish in 2001 is the highest since the early 70's. The forecast for 2002 is for another strong return of approximately 32,000 wild steelhead to Lower Granite Dam.

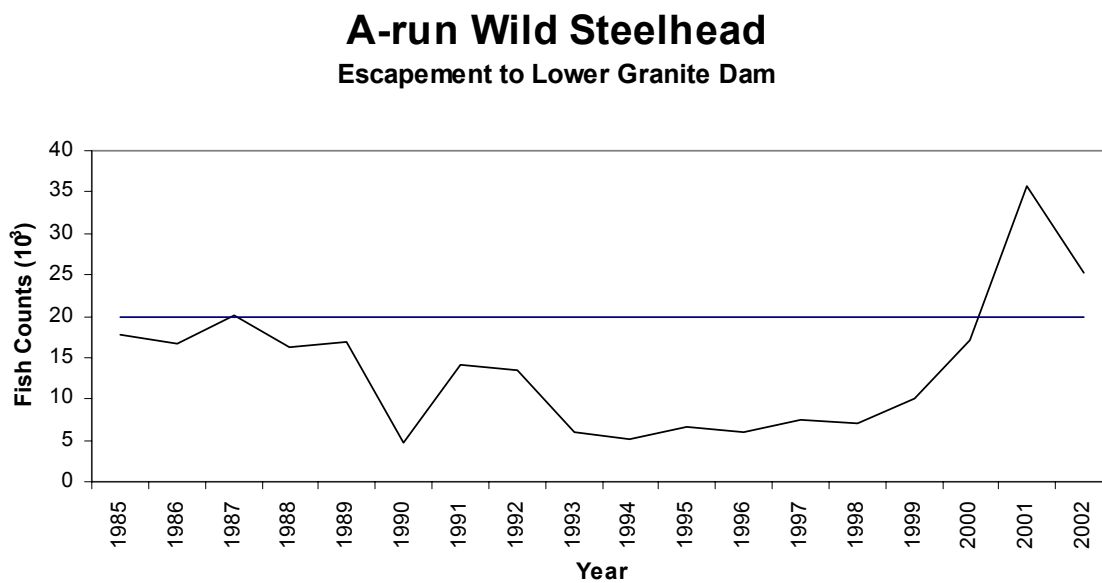
These broad scale trends in the abundance of steelhead were reviewed using data available through 1998 through the PATH process. The report concluded that the initial substantial decline was coincident with the declining trend in downstream passage survival. However, the more recent decline in abundance observed over the last decade or more is not coincident with declining passage survival but can be at least partially accounted for by a shift in climatic regimes which has affected ocean survival (Marmorek 1998). As discussed elsewhere the recent higher returns may be related to improving ocean conditions which would be consistent with the PATH hypothesis.

The available data allows us to distinguish the abundance of the A-run and B-run components of Snake Basin steelhead only since 1985. Both components declined through the 90's, but the decline for B-run steelhead has been the most significant. The 4-year average count of A-run steelhead at LGD was 17,700 beginning in 1985 compared to a recent average of 17,500 although there was an extended period of decline in between (Figure 2). The comparative four year averages for B-run steelhead were 6,100 and 2,300 (Figure 3). The counts of natural-origin A-run steelhead have been higher in the last two years with a count of over 17,000 in 2000 and almost 36,000 in 2001. Although the count of B-run steelhead reached a record low of just 909 fish in 1999, counts over the last two years have been on the order of 3,000 fish. The 2002 forecasts are for returns of 25,300 wild A-run and 7,100 wild B-run steelhead to LGD.

Preliminary information for 2002 suggest that returns will be generally higher as expected. The counts at Bonneville Dam through July 18 were more than twice the 10 year average and about 25% lower than those observed during the record return in 2001 which is consistent with preseason expectations.



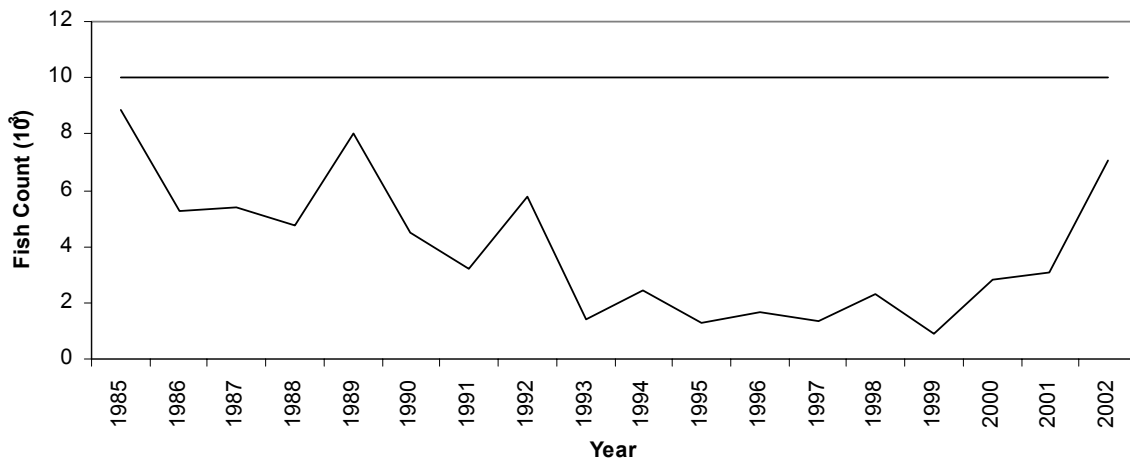
**Figure 1**



**Figure 2.** Escapement goal is 20,000 fish

### B-run Wild Steelhead

Escapement to Lower Granite Dam



**Figure 3.** Escapement Goal is 10,000 fish

Comparison of recent dam counts with escapement objectives provides perspective regarding the status of the ESU. The management objective from the CRFMP for SR steelhead was to return 30,000 natural/wild steelhead to LGD. The All Species Review (ASR) (TAC 1997) further clarifies that this objective is subdivided into 20,000 A-run and 10,000 B-run steelhead to LGD. There is also a table in the ASR that further divides the escapement goals by sub-basin (e.g., 8,000 B-run steelhead to the Clearwater and 2,000 to the Salmon). Idaho reevaluated these escapement objectives using estimates of juvenile production capacity. This alternative methodology leads to estimates of 22,000 for A-run and 32,700 for B-run steelhead (IDFG 1992). Idaho's analysis did not include escapement goal estimates for A-run steelhead returning to the Imnaha or Grand Ronde rivers. Escapement goals for these rivers were calculated here for comparison using the same methods and assumptions as were used by IDFG. The four LCR tribes provided yet another set of goals for SR steelhead in their Tribal Restoration Plan - Wy-Kan-Ush-Me-Wa-Kish-Wit Spirit of the Salmon (CRITFC 1995). The tribes' goals are incomplete in that they do not specify escapement objectives for either A-run or B-run steelhead in the Salmon River. The tribal goals are nonetheless generally higher than the 10,000/20,000 goals contained in the CRFMP (Table 5).

<b>Table 5. Alternative Escapement Goals For Snake River Steelhead</b>				
<b>Sub-basin</b>	<b>Stock</b>	<b>TAC ASR</b>	<b>IDFG</b>	<b>TRP</b>
Clearwater	B	8,000	16,931	12,000
Salmon	B	2,000	15,785	<sup>a</sup>
<b>B-run subtotal</b>	<b>B</b>	<b>10,000</b>	<b>32,716</b>	<b>12,000</b>
Clearwater	A	-	2,150	1,000
Salmon	A	10,000	20,010	<sup>a</sup>
Grand Ronde	A	8,000	7,600 <sup>b</sup>	18,450
Imnaha	A	2,000	3,100 <sup>b</sup>	2,100
<b>A-run subtotal</b>	<b>A</b>	<b>20,000</b>	<b>32,860</b>	<b>22,000</b>
<b>Total</b>		<b>30,000</b>	<b>65,576</b>	<b>34,000</b>

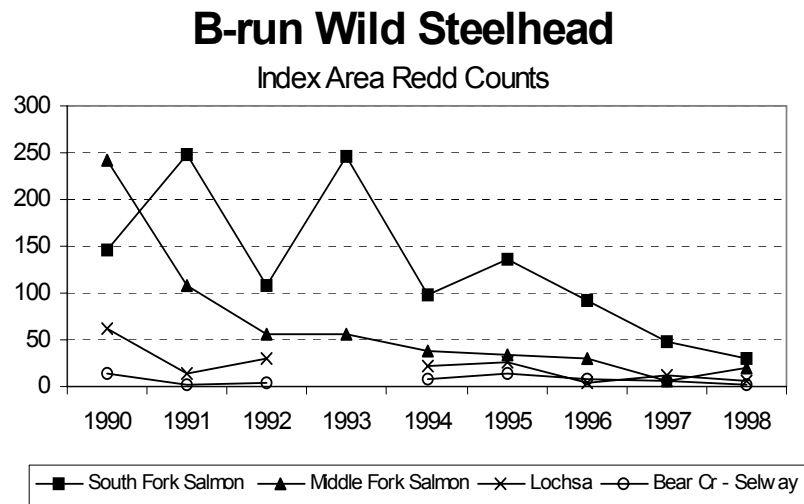
<sup>a</sup> The TRP does not identify escapement goals for A or B-run steelhead in the Salmon River.

<sup>b</sup> Escapement goals for the Grand Ronde and Imnaha were derived from smolt estimates using the same assumptions and methods used by IDFG for Idaho subbasins.

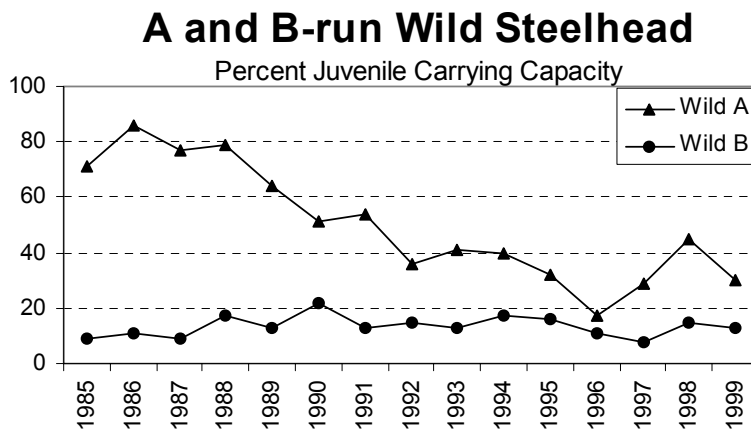
Figures 2 and 3 show escapement goals of 20,000 and 10,000 for A-run and B-run SR steelhead, respectively, to provide some perspective in relation to the abundance trend. However, these are the lowest of the currently available alternative goals.

The State of Idaho has conducted redd count surveys in all of the major subbasins since 1990 (Figure 4). Although the surveys are not intended to quantify adult escapement, they can be used as indicators of relative trends. The sum of redd counts in natural-origin B-run production subbasins declined from 467 in 1990 to 59 in 1998. The declines are evident in all four of the primary B-run production areas. Index counts in the natural-origin A-run production areas have not been conducted with sufficient regularity in place and time to similarly characterize the relative trend in escapement in A-run production areas. Idaho has not conducted index redd count surveys for steelhead since 1998.

Idaho has also conducted surveys for juvenile abundance in index areas throughout the SRB since 1985 (Figure 5). Parr densities of A-run steelhead (refers to the intermediate juvenile life stage) have declined from an average of about 78% of carrying capacity in 1985 to an average of about 30% in recent years through 1999. Parr densities of B-run steelhead have been low, but relatively stable since 1985 averaging 10-15% of carrying capacity through 1995. Parr densities in both A and B-run tributaries were generally lower in 1996 and 1997, but increased modestly in 1998 and 1999. Comparable information for 2000-2001 is not yet available. As noted above, the adult escapements in 1999 and 2000, and particularly 2001, were higher than they have been in recent years. We would expect these to be reflected in the 2001 - 2003 parr density estimates.



**Figure 4.**



**Figure 5**

It is apparent from the available data that B-run steelhead are much more depressed than the A-run component. In evaluating the status of the Snake Basin steelhead ESU it is pertinent to consider whether B-run steelhead represent a "significant portion" of the ESU. This is particularly relevant because the tribes have proposed in the past to manage the SR steelhead ESU as a whole without distinguishing between components. Despite their reservations, the biological assessment does propose separate harvest rates for the A and B-run components.

It is first relevant to put the Snake Basin into context. The Snake Basin historically supported over 55% of total natural-origin production of steelhead in the Columbia Basin and now has approximately 63% of the Columbia Basin's natural production potential for natural-origin steelhead (Mealy 1997). B-run steelhead occupy four major subbasins including two on the Clearwater (Lochsa and Selway) and two on the Salmon River (Middle Fork and South Fork Salmon), areas that for the most part are not occupied by A-run steelhead. Some natural production of B-run steelhead also occurs in parts of the mainstem Clearwater and its major tributaries. As discussed above, there are alternative escapement objectives for B-run steelhead of 10,000 (CRFMP) and 32,700 (Idaho). B-run steelhead therefore represent at least 1/3 and as much as 3/5 of the production capacity of the ESU.

B-run steelhead are distinguished from the A-run component by their unique life history characteristics. B-run steelhead were traditionally distinguished as larger and older, later-timed fish that return primarily to the South Fork Salmon, Middle Fork Salmon, Selway, and Lochsa rivers. The recent review by TAC concluded that different populations of steelhead do have different size structures with populations dominated by larger fish (>77.5 cm) occurring in the traditionally defined B-run basins (TAC 1999). Larger fish occur in other populations throughout the basin, but at much lower rates. (Evidence suggests that fish returning to the Middle Fork Salmon and Little Salmon are intermediate in that they have a more equal distribution of large and small fish.)

B-run steelhead are also generally older. A-run steelhead are predominately age-1-ocean fish while most B-run steelhead generally spend two or more years in the ocean prior to spawning. The differences in ocean age are primarily responsible for the differences in the size of A and B-run steelhead. However, B-run steelhead are also thought to be larger at age than A-run fish. This may be due, at least in part, to the fact that B-run steelhead leave the ocean later in the year than A-run steelhead and thus have an extra month or more of ocean residence at a time when growth rates are generally at their greatest.

Historically there was a distinctly bimodal pattern of freshwater entry that was used to distinguish A-run and B-run fish. A-run steelhead were presumed to cross Bonneville Dam from June to late August while B-run steelhead enter from late August to October. TAC also reviewed the available information on timing and confirmed that the majority of large fish still have a later timing as counted at Bonneville with 70% of the larger fish crossing the dam after August 26, the traditional date method cutoff for separating A and B-run fish. The timing of earlier A-run fish has shifted somewhat later thereby reducing the timing separation that was so apparent in the 60's and 70's. However, TAC concluded that the timing of the larger, natural-origin B-run fish is unchanged (TAC 1999).

As pointed out above, the geographic distribution of B-run steelhead is restricted to particular watersheds within the SRB (areas of the mainstem Clearwater, Selway and Lochsa Rivers, South and Middle Forks of the Salmon River). Although recent genetic data are not yet available for steelhead populations in the Salmon River, the Dworshak NFH stock and natural populations in the Selway and Lochsa Rivers are the most genetically distinct populations of steelhead in the

SRB (NMFS, unpublished). In addition, the Selway and Lochsa River populations from the Middle Fork Clearwater appear to be very similar to each other genetically, and naturally produced rainbow trout from the North Fork Clearwater River (above Dworshak Reservoir) clearly show an ancestral genetic similarity to Dworshak NFH steelhead. The existing genetic data, the restricted geographic distribution of B-run steelhead in the SRB, and the unique life history attributes of these fish (i.e. larger, older adults with a later distribution of run timing compared to A-run steelhead in other portions of the CRB) clearly support the discrimination of B-run steelhead as a biologically significant and distinct component of the SR ESU.

Information regarding the geography, ecology, and genetics of the ESU are relevant to population identification. Based on NMFS understanding of current information, it is reasonable to conclude at a minimum that each of the major subbasins in the SR steelhead ESU represent a population within the context of this discussion. As discussed in the VSP paper, populations are presumed to be reproductively isolated. A-run populations would therefore include at least the tributaries to the lower Clearwater, the upper Salmon River and its tributaries, the lower Salmon River and its tributaries, the Grand Ronde, Imnaha, and possibly the Snake mainstem tributaries below Hells Canyon Dam. B-run populations would include both the Middle Fork and South Fork Salmon River and the Lochsa and Selway which are major tributaries of the upper Clearwater, and possibly the B-run production areas in the mainstem Clearwater.

These basins are, for the most part, large geographical areas and it is quite possible that there is additional population structure within at least some of these basins. However, that has not been demonstrated to date and for the sake of this discussion we will assume that there are a minimum of five populations of A-run steelhead and five populations of B-run steelhead in the SR ESU. Table 6 shows the escapement objectives for A and B-run production areas in Idaho based on estimates of smolt production capacity.

NMFS recently identified geographic spawning aggregations and interim abundance targets for SR steelhead to provide provisional guidance pending more formal designations of the population structure of the ESU and associated abundance recovery goals (Lohn 2002). A total of 19 spawning aggregations were identified including the Tucannon River and Asotin Creek which were not included in the considerations above. Interim abundance targets were identified for each of the spawning aggregations which summed to a total of 53,700 compared to a total of 64,770 from Table 6. Although there are some differences in the details, either approach suggests that the ESU does have significant population structure and that total escapements on the order of 50,000 to 60,000 adults with adequate distribution would be consistent with a healthy ESU.

Table 6. Adult steelhead escapement objectives from Idaho based on estimates of 70% smolt production capacity.

A-run Production Areas		B-run Production Areas	
Upper Salmon	13,570	Mid Fk Salmon	10,000
Lower Salmon	6,300	Sth Fk Salmon	5,200
Clearwater	2,100	Lochsa	5,100
Grand Ronde	7,600 <sup>1</sup>	Selway	7,700
Imnaha	3,100 <sup>1</sup>	Clearwater	4,100
Total	32,670	Total	32,100 <sup>2</sup>

<sup>1</sup> See Table 5.

<sup>2</sup> Does not include an additional 600 fish for the East Fork Salmon River above the weir.

A comparison of measures of abundance to critical populations thresholds provides further perspective regarding the status of SRB populations. The VSP paper provides several rules of thumb that are intended to serve as guidelines for setting population specific thresholds (McElhany et al. 2000). However, since they are general, and not population specific, threshold determinations for selected populations should be made by considering both the rules of thumb, and other more population-specific information. Unfortunately, the VSP paper does not lead to a clear decision regarding critical population thresholds for SR steelhead.

The Biological Requirements Work Group (BRWG 1994) took genetic considerations and other factors into account in their effort to provide guidance with respect to a lower population threshold for Snake River spring/summer chinook. They recommended that annual escapements of 150 and 300, for small and large populations, represented levels below which survival becomes increasingly uncertain due to various risk factors and lack of information regarding populations responses at low spawning levels.

In a recent effort, a group regional of scientists and managers considered similar issues related to the biological requirements of UCR spring chinook and steelhead. Their report is referred to as the QAR report (Ford et al. 2001). The report makes recommendations concerning quasi-extinction levels and cautionary levels for each of the Methow, Wenatchee, and Entiat populations. The QAR recommendations for the UCR populations are not directly applicable to SR steelhead. In general, the populations, or geographic areas at least, considered in the Snake are larger than those in the UCR. Results from the QAR report nonetheless provide some further perspective.

Quasi-extinction levels are defined as abundances at which populations are believed to 1) be at extremely high risk of extinction in the immediate future, and 2) face risks that are not usually incorporated into simple population extinction models. The quasi-extinction levels identified



were 50 or fewer spawners per year for the Methow and Wenatchee, and 30 or fewer per year for the Entiat for five or more consecutive years. These values were recommended for both UCR spring chinook and steelhead.

Cautionary abundance levels are described as those below which demographic, genetic, and other risk factors to the populations become of increasing concern, and uncertainties in production response become magnified. Generally, these levels were determined from historical spawning records as the level below which the population would be expected to fall only about 10% of the time. Recommended cautionary levels for the Wenatchee, Methow, and Entiat UCR spring chinook populations were 1200, 750, and 150, respectfully. These compare to recommended recovery abundance levels of 3750, 2000, and 500. More recently, NMFS identified interim abundance targets for UCR steelhead which for the Wenatchee, Methow, and Entiat were 2,500, 2,500 and 500 (Lohn 2002). No further guidance was provided regarding cautionary levels, but the comparison with those provide for spring chinook provide some perspective.

For specific populations, including SR steelhead, lower abundance thresholds will have to be determined based on relevant factors including the spatial structure of spawning aggregations and the relationship of abundance to spawners per stream kilometer. For SR steelhead, the number of populations was estimated conservatively and there may well be a finer level of resolution in the populations structure of the ESU as suggested by (Lohn 2002). Even if not these are large geographic areas with spawning capacities in excess of 10,000 fish in some cases. A case specific application of the related considerations suggests that lower abundance thresholds, however they are characterized, should be set at the upper end of the range of those discussed above.

The average return to LGD of natural-origin A-run steelhead over the last four years is 17,400 (range 7,100 - 35,800). An equal distribution of spawners would result in a average return of 3,480 spawners per population. If the fish distribute in proportion to the respective subbasin capacities, the return to each would range between 1,118 and 7,227. This analysis suggests that A-run steelhead, though depressed, are well above quasi-extinction levels and likely cautionary levels as well based on the available guidance.

The average return to Lower Granite of natural-origin B-run steelhead over the last four years is about 2,300 fish (range 900 - 3,100). Average escapement per population is 460 if the fish are presumed to distribute equally among the five populations. If the fish distribute in proportion to the respective subbasin capacities, the return to each would range between 294 and 717. Populations of B-run steelhead are therefore well above quasi-extinction levels, at least as defined for UCR populations, but are likely at or below what we can reasonably expect to be cautionary abundance levels for SR steelhead populations.

Hatchery populations, if genetically similar to their natural-origin counter parts, provide a safeguard against the short-term risk of extinction of the natural populations although the

associated long-term risks are less clear. The Imnaha and Oxbow hatchery stocks are A-run stocks currently included in the SR steelhead ESU. The Pahsimeroi and Wallowa hatchery stocks may also be appropriate and available for use in developing supplementation programs. NMFS has required in their recent Biological Opinion on hatchery operations in the CRB that this program begin to transition to a local-origin broodstock to provide a source for future supplementation efforts in the lower Salmon River (NMFS 1999a). The other stocks provide more immediate opportunity to initiate supplementation programs at least within some basins. However, it may also be necessary and desirable to develop additional broodstocks that can be used for supplementation in other natural production areas. Despite uncertainties related to the likelihood that supplementation programs can accelerate the recovery of naturally spawning populations, these hatchery stocks do provide a safeguard against the further decline of natural-origin populations.

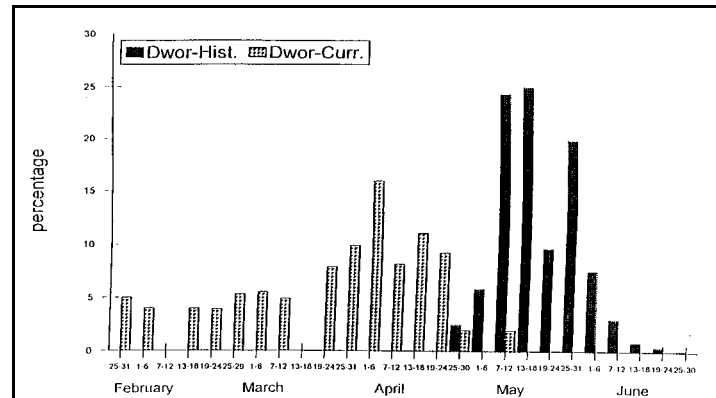
There is one B-run hatchery stock in the Snake Basin located at the Dworshak NFH. The Dworshak stock was developed from natural-origin steelhead from within the North Fork Clearwater, is largely free of introductions from other areas, and was included as part of the ESU although not part of the listed population. However, past hatchery practices and possibly changes in flow and temperature conditions related to Dworshak Dam have led to substantial divergence in spawn timing compared to what was observed historically in the North Fork Clearwater, and to natural-origin populations in other parts of the Clearwater Basin. The spawn timing of hatchery stocks is much earlier than it was historically (Figure 6) and this may limit the success of supplementation efforts. Past supplementation efforts in the South Fork Clearwater River using this stock have been largely unsuccessful, although better out planting practices may yield different results. In addition, the unique genetic character of Dworshak Hatchery steelhead noted above may limit the degree to which the stock can be used for supplementation in other parts of the Clearwater and particularly in the Salmon River B-run basins. Supplementation efforts in those areas, if undertaken, will more likely have to rely on the development of local broodstocks which do not exist at this time. Supplementation opportunities in many of the B-run production areas will be limited in any case because of logistical difficulties in getting to and working in these high mountain, wilderness areas. Opportunities to accelerate the recovery of B-run steelhead through supplementation even if successful are therefore limited. Maximizing escapement of natural-origin steelhead in the near term is therefore essential.

For the SR steelhead ESU as a whole, NMFS estimates that the median population growth rate ( $\lambda$ ) over the base period<sup>6</sup> ranges from 0.91 to 0.70 (Table 4), decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000a). NMFS has also estimated the risk of absolute extinction for the A- and B-runs, using the same range of assumptions about the relative

---

<sup>6</sup>Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1997 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years is 0.01 for A-run steelhead and 0.93 for B-run fish (Table B-5 in McClure et al. 2000a). At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is 1.00 for both runs (Table B-6 in McClure et al. 2000a).



**Figure 6**

### 2.3.2.2 Upper Columbia River Steelhead

UCR steelhead inhabit the CR reach and its tributaries upstream of the Yakima River. This region includes several rivers that drain the east slopes of the Cascade Mountains and several that originate in Canada (only U.S. populations are included in the ESU). Dry habitat conditions in this area are less conducive to steelhead survival than in many other parts of the Columbia basin (Mullan et al. 1992a). Although the life history of this ESU is similar to that of other inland steelhead, smolt ages are some of the oldest on the West Coast (up to 7 years old), probably due to the ubiquitous cold water temperatures (Mullan et al. 1992b). Adults spawn later than in most downstream populations, remaining in freshwater up to a year before spawning.

Although runs from 1933 through 1959 may have already been affected by fisheries in the lower river, dam counts suggest a pre-fishery run size of more than 5,000 adults above Rock Island Dam. The return of UCR natural-origin steelhead to Priest Rapids Dam has increased steadily over the last three years with high of almost 5,700 in 2001 (Table 7). The sum of the interim abundance targets for UCR steelhead is 5,500 (Lohn 2002). The return in 2002 is expected to be about half way between those observed in 2000 and 2001. Early season counts at Bonneville Dam are generally on track with the preseason expectations.

Most current natural production occurs in the Wenatchee and Methow river systems, with a smaller run returning to the Entiat River. Very limited spawning also occurs in the Okanogan River basin. Most of the fish spawning in natural production areas are of hatchery origin.

Indications are that natural populations in the Wenatchee, Methow, and Entiat rivers are not self-sustaining.

UCR hatchery steelhead are included in the ESU and are also listed as endangered. The hatchery component is relatively abundant and routinely exceeds hatchery supplementation program needs by a substantial margin (Table 7). The return of nearly 30,000 hatchery steelhead to Priest Rapids Dam in 2001 was the second highest observed since 1977. The naturally spawning population of UCR steelhead have been augmented for a number of years by stray hatchery fish that have spawned naturally. Replacement ratios for naturally spawning fish (natural-origin and hatchery strays) are quite low, on the order of 0.3. This very low return rate suggests either that the productivity of the system is very low and the hatchery strays are largely supporting the population, or that the natural-origin fish are returning at or just below the replacement rate and the hatchery strays are not contributing substantially to subsequent adult returns. Obviously the truth likely lies somewhere between the extremes. This is a good example of the fundamental uncertainty related to the contribution of hatchery-origin fish that has emerged from the CRI analysis. The presence of hatchery-origin fish on the spawning grounds and our uncertainty about their contribution to future returns confounds our ability to assess the current productivity of the system and, therefore, how much it must be improved to achieve survival and recovery objectives.

Because of concerns related to the low abundance of some of the populations and apparent shortfalls in system productivity, NMFS has authorized several steelhead supplementation programs in the upper CRB. Efforts are underway to diversify broodstocks used for supplementation in an effort to minimize the differences between hatchery and natural-origin fish and to minimize the concerns associated with supplementation. NMFS expects that the supplementation program will benefit the listed fish due to the early life history survival advantage expected from the hatchery action. However, there are also substantive concerns about the long term effect on the fitness of natural-origin populations resulting from continuous long term infusion of hatchery-influenced spawners (Busby et al. 1996). In summary, the hatchery component of the UCR listed steelhead is abundant. The natural component was quit depressed through most of the decade of the 90's, but has rebounded in recent years. It is hoped that supplementation efforts can be used to moderate potential future declines in abundance until the necessary, long-term improvements in system productivity take effect.

**Table 7.** Adult summer steelhead counts at Priest Rapids, Rock Island, Rocky Reach, and Wells Dams (FPC 2001).

Year	Priest Rapids		Rock Island	Rocky Reach	Wells
	Count	Wild Origin (Viola 2001)	Count	Count	Count
1977	9,812		9,925	7,416	5,382
1978	4,545		3,352	2,453	1,621
1979	8,409		7,420	4,896	3,695
1980	8,524		7,016	4,295	3,443
1981	9,004		7,565	5,524	4,096
1982	11,159		10,150	6,241	8,418
1983	31,809		29,666	19,698	19,525
1984	26,076		24,803	17,228	16,627
1985	34,701		31,995	22,690	19,757
1986	22,364	2,342	22,867	15,193	13,234
1987	14,013	4,058	12,706	7,172	5,195
1988	10,200	2,670	9,358	5,678	4,415
1989	10,718	2,685	9,351	6,119	4,608
1990	7,837	1,585	6,936	5,014	3,819
1991	13,968	2,799	11,018	7,741	7,715
1992	13,720	1,618	12,398	7,457	7,120
1993	5,428	890	4,591	2,815	2,400
1994	6,735	855	5,618	2,823	2,138
1995	4,370	993	4,070	1,719	946
1996	8,600	843	7,305	5,774	4,127
1997	8,942	785	7,726	7,726	4,107
1998	5,847	928	4,962	4,442	2,668
1999	8,277	1,374	6,361	4,815	3,557
2000	11,364	2,341	10,515	8,272	6,280
2001	29,844	5,670	28,438	21,973	17,412

<sup>1</sup> preliminary.

For the UCR steelhead ESU as a whole, NMFS estimates that the median population growth rate ( $\lambda$ ) over the base period<sup>7</sup> ranges from 0.94 to 0.66 (Table 4), decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000a). NMFS has also estimated the risk of absolute extinction for the aggregate UCR steelhead population, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years is 0.25 (Table B-5 in McClure et al. 2000a). Assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is 1.00 (Table B-6 in McClure et al. 2000a).

### **2.3.2.3 Middle Columbia River Steelhead**

The MCR steelhead ESU occupies the CRB from Mosier Creek, OR, upstream to the Yakima River, WA, inclusive (61 FR 41541; August 9, 1996). Steelhead from the SRB (described elsewhere) are excluded. This ESU includes the only populations of inland winter steelhead in the United States, in the Klickitat River and Fifteenmile Creek (Busby et al. 1996). Two hatchery populations are included in this ESU, the Deschutes River stock and the Umatilla River stock; listing for these stocks was not considered warranted.

The ESU is in the intermontane region and includes some of the driest areas of the Pacific Northwest, generally receiving less than 40 cm of rainfall annually (Jackson 1993). Vegetation is of the shrub-steppe province, reflecting the dry climate and harsh temperature extremes. Because of this habitat, occupied by the ESU, factors contributing to the decline include agricultural practices, especially grazing, and water diversions/withdrawals. In addition, hydropower development has impacted the ESU through loss of habitat above hydro projects, and mortalities associated with migration through the CR hydro system.

Life history information for steelhead of this ESU indicates that most MCR steelhead smolt at 2 years and spend 1 to 2 years in salt water (i.e., 1-ocean and 2-ocean fish, respectively) prior to re-entering fresh water, where they may remain up to a year prior to spawning (Howell et al., 1985). Within this ESU, the Klickitat River is unusual in that it produces both summer and winter steelhead, and the summer steelhead are dominated by 2-ocean steelhead, whereas most other rivers in this region produce about equal numbers of both 1-and 2-ocean steelhead.

Within the ESU, the Yakima, Umatilla and Deschutes River basins have shown an overall upward trend, although all tributary counts in the Deschutes River are downward and the

---

<sup>7</sup>Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1996 adult returns. Population trends are projected under the assumption that all conditions will stay the same into the future.

Yakima River is recovering from extremely low abundance in the early 1980s. The John Day River probably represents the largest native, natural spawning stock in the ESU, and the combined spawner surveys for the John Day River have been declining at a rate of about 15 percent per year since 1985. However, estimates based on dam counts show an overall increase in steelhead abundance, with a relatively stable naturally-produced component. The NMFS, in proposing this ESU be listed as threatened under the ESA, cited low returns to the Yakima River, poor abundance estimates for Klickitat River and Fifteenmile Creek winter steelhead, and an overall decline for naturally-producing stocks within the ESU.

Hatchery fish are widespread and stray to spawn naturally throughout the region. Recent estimates of the proportion of natural spawners with hatchery origin range from low (Yakima River, Walla Walla River, John Day River) to moderate (Umatilla River, Deschutes River). Most hatchery production in this ESU is derived primarily from within-basin stocks. One recent area of concern is the increase in the number of SR hatchery (and possibly wild) steelhead that stray and spawn naturally within the Deschutes River Basin. Studies have been proposed to evaluate hatchery programs within the SRB that have shown high rates of straying into the Deschutes River, and to make changes to minimize straying to rivers within the MCR ESU.

For the MCR steelhead ESU as a whole, NMFS estimates that the median population growth rate ( $\lambda$ ) over the base period<sup>8</sup> ranges from 0.88 to 0.75 (Table 4), decreasing as the effectiveness of hatchery fish spawning in the wild increases compared with that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000a). NMFS has also estimated the risk of absolute extinction for four of the subbasin populations, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years ranges from zero for the Yakima River summer run to 1.00 for the Umatilla River and Deschutes River summer runs (Table B-5 in McClure et al. 2000a). Assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years ranges from zero for the Yakima River summer run to 1.00 for the Deschutes River summer run (Table B-6 in McClure et al. 2000a).

### **2.3.2.3 Lower Columbia River Steelhead**

The LCR ESU includes naturally-produced steelhead returning to CR tributaries on the Washington side between the Cowlitz and Wind rivers in Washington and on the Oregon side between the Willamette and Hood rivers, inclusive. In the Willamette River, the upstream boundary of this ESU is at Willamette Falls. This ESU includes both winter and summer

---

<sup>8</sup>Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period that varies between subbasin populations. Population trends are projected under the assumption that all conditions will stay the same into the future.

steelhead. Two hatchery populations are included in this ESU, the Cowlitz Trout Hatchery winter-run stock and the Clackamas River stock (ODFW stock 122); listing for these hatchery populations was not considered necessary.

Available historical and recent LCR steelhead abundance information is summarized in Busby et al. (1996). No estimates of historical (pre-1960s) abundance specific to this ESU are available. Because of their limited distribution in upper tributaries and the urbanization surrounding the lower tributaries (e.g., the lower Willamette, Clackamas, and Sandy Rivers run through Portland or its suburbs), summer steelhead appear to be at more risk from habitat degradation than are winter steelhead. The lower Willamette, Clackamas, and Sandy steelhead trends are stable or slightly increasing, but this is based on angler surveys for a limited time period, and may not reflect trends in underlying population abundance. Total annual run size data are only available for the Clackamas River (1,300 winter steelhead, 70% hatchery; 3,500 natural-origin summer steelhead).

Population dynamics indicate that the Oregon component of the LCR steelhead ESU is at risk such that the capacity to survive future periods of environmental stress is unacceptably low (Chilcote 1998). The recent collapse of winter steelhead in the Clackamas River and the status of summer steelhead in the Hood River (which together comprise 33% of the ESU) are of special concern. The Kalama River population is the only one in Washington State considered healthy (WDFW 1997). All of the other winter steelhead populations (i.e., those in the Cowlitz, Coweeman, North Fork and South Fork Toutle, Green, North Fork Lewis, and Washougal rivers) are considered depressed (WDFW 1997). The status of populations of winter steelhead in Hamilton Creek and the Wind River is unknown. The WDFW trapped fish at Shiperd Falls on the Wind River during winter 1999-2000 and will use these data to develop preliminary estimates of steelhead abundance. Among summer steelhead, populations from the Kalama River, the North and East Forks of the Lewis River, and the Washougal River are considered depressed, and the Wind River stock is classified as critical (WDFW 1997).

Recent estimates of the proportion of hatchery fish on the winter-run steelhead spawning grounds are more than 80% in the Hood and Cowlitz rivers and 45% in the Sandy, Clackamas, and Kalama rivers. On the summer-run steelhead spawning grounds in the Kalama River, hatchery fish make up approximately 75% of the total run. Out of 14 steelhead populations for which data are available, only 3 have no hatchery influence: the Washougal River summer run and the Panther and Trout Creek runs in the Wind River basin. NMFS is unable to identify any natural populations of steelhead in this ESU that could be considered healthy, especially in light of new genetic data from WDFW that indicate some introgression between the Puget Sound Chambers Creek Hatchery stock and wild steelhead in this ESU (Phelps et al. 1997). In addition, summer steelhead, native to the Hood, Lewis, Washougal and Kalama rivers, have been introduced into the Sandy and Clackamas rivers. Naturally spawning populations of winter steelhead appear to have been negatively affected by these introductions, probably through interbreeding and competition (Chilcote 1998).



For the LCR steelhead ESU as a whole, NMFS estimates that the median population growth rate ( $\lambda$ ) over the base period<sup>9</sup> ranges from 0.98 to 0.78 (Table 4), decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000a). NMFS has also estimated the risk of absolute extinction for seven of the spawning aggregations, using the same range of assumptions about the relative effectiveness of hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years ranges from zero for the Kalama River summer run and the Clackamas River and Kalama River winter runs to 1.00 for the Clackamas River summer run and the Toutle River winter run (Table B-5 in McClure et al. 2000a). Assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years rises to 1.00 for all but one population (the risk of extinction is 0.86 for the Green River winter run; Table B-6 in McClure et al. 2000a).

### **2.3.3 Chum Salmon**

The CR historically contained large runs of chum salmon that supported a substantial commercial fishery in the first half of this century. These landings represented a harvest of more than 500,000 chum salmon in some years. Currently chum salmon are limited to tributaries below Bonneville Dam, with the majority of fish spawning on the Washington side of the Columbia River. Many lower Columbia tributaries once produced chum, however, significant chum natural production is currently limited to just two areas: Grays River near the mouth of the Columbia River, and Hardy and Hamilton creeks that are just downstream of Bonneville Dam. Small numbers of adult chum salmon have been observed in several other LCR tributaries. A few chum cross Bonneville Dam in some years, but these are likely lost to the system as there are no known spawning areas above Bonneville Dam. Grays River chum salmon enter the CR from mid-October to mid-November, but apparently do not reach the Grays River until late October to early December. These fish spawn from early November to late December. Fish returning to Hamilton and Hardy Creeks begin to appear in the CR earlier than Grays River fish (late September to late October) and have a more protracted spawn timing (mid-November to mid-January).

Of the three primary populations in the LCR, Grays River and Hamilton Creek are considered depressed though not critical, while the Hardy Creek population is considered healthy (WDF and WDW 1993) based on long term escapement trends. Hymer (1993, 1994) and WDF and WDW (1993) monitored returns of chum salmon to three streams in the CR and suggested that there may be a few thousand, perhaps up to 10,000, chum salmon spawning annually in the CRB.

---

<sup>9</sup>Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period that varies between spawning aggregations. Population trends are projected under the assumption that all conditions will stay the same into the future.

The Grays River is located near the mouth of the Columbia River. Escapement to the Grays River has ranged from several hundred to over 5,000 over the last ten years. A hatchery supplementation program was initiated in the Grays River beginning in 1996 using native broodstock to help rebuild the population. Peak chum salmon counts per mile averaged 218 from 1996-1999 (WDFW 2001).

Hamilton Creek is located 3.0 miles below Bonneville Dam. There is only about 1 mile of spawning habitat in Hamilton Creek and its tributaries. Escapements have averaged less than 100 fish in recent years. The WDFW recently completed a major restoration effort on Spring Channel which is a spring fed tributary to Hamilton Creek that supports chum spawning. Peak chum salmon counts per mile averaged 247 from 1996-1999 (WDFW 2001).

Hardy Creek is located just downstream of Hamilton Creek. Chum spawn in the lower 1.5 miles of the stream. Annual escapements over the last 10 years have ranged from 22 to 1,153 spawners, but are generally increasing. Hardy Creek is now incorporated into the Pierce National Wildlife Refuge and has benefitted from recent habitat improvement programs as well. Peak chum salmon counts per mile averaged 207 from 1996-1999 (WDFW 2001).

Although current abundance is only a small fraction of historical levels, and much of the original inter-population diversity has presumably been lost, the total spawning run of chum salmon to the CR has been relatively stable since the mid 1950s, and total natural escapement for the ESU is probably at least several thousand fish per year.

NMFS estimates a median population growth rate ( $\lambda$ ) over the base period<sup>10</sup>, for the ESU as a whole, of 1.04 (Table 4) (Tables B-2a and B-2b in McClure et al. 2000a). Because census data are peak counts (and because the precision of those counts decreases markedly during the spawning season as water levels and turbidity rise), NMFS is unable to estimate the risk of absolute extinction for this ESU.

### **3.0 ENVIRONMENTAL BASELINE**

The purpose of this section is to identify the past and present effects of all Federal, state, tribal, local government, or private activities in the action area, the anticipated effects of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the effect of state or private actions which are contemporaneous with the consultation in process. These factors affect the species' environment or critical habitat in the

---

<sup>10</sup>Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals are based on population trends observed during a base period from 1980 through 1998 adult returns for the Grays River mainstem and the West Fork, Crazy Johnson, and Hamilton Creek spawning aggregations and including the 1999 adult returns for Hardy Creek and Hamilton Springs. Population trends are projected under the assumption that all conditions will stay the same into the future.

action area. The factors are described in relation to the action area biological requirements of the species.

In addition to harvest activities, the activities having the greatest effect on the environmental baseline generally fall into four categories: hydropower system impacts on juvenile outmigration and adult return migration; habitat degradation effects on water quality and availability of adequate incubation and rearing locations; adverse genetic and competitive impacts from artificial production programs; and fluctuations in natural conditions.

### **3.1 Description of Action Area**

The action area encompasses the Columbia River from its mouth upstream to the Wanapum Dam, including its tributaries (with the exception of the Willamette River). Proposed non-Indian fisheries would occur primarily in the Columbia River and its tributaries below Bonneville Dam (Zones 1-5). Proposed treaty Indian fisheries would occur primarily in the Columbia River and its tributaries above Bonneville Dam (Zone 6). The action area therefore includes portions of the states of Washington, Oregon, and Idaho.

### **3.2 Biological Requirements in Action Area**

Seven of the 12 listed salmonid ESUs in the CRB are potentially affected by the proposed fisheries considered in this opinion (Table 2). Biological requirements during the adult life history stage are obtained through access to essential habitat features. Essential features include adequate 1) substrate (especially spawning gravel), 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover/shelter, 7) food, 8) riparian vegetation, 9) space, and 10) migration conditions (58 FR 68546 for SR salmon and 65 FR 773 for all other CRB salmonids). These features are nearly identical to those characterized as Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (PFMC 1999).

#### **3.2.1 Essential Habitat Features in Action Area**

The sections below describe essential habitat features for each of the relevant habitat types: 1) adult migration corridors, and 2) spawning areas in the action area discussed in the following sections.

##### Adult Migration Corridors

Essential habitat features for adult migration corridors include all the essential habitat features except for adequate food.

##### Spawning Areas

Essential habitat features for spawning areas include all the essential habitat features except for adequate food and migration conditions.

### **3.2.2 Adequacy of Habitat Conditions**

Regulations implementing Section 7(a)(2) of the ESA define “destruction or adverse modification” as “a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species.” Adverse effects on a constituent element of critical habitat generally do not result in a determination of “adverse modification” unless that loss, when added to the environmental baseline, is likely to result in an appreciable diminishment of the value of the critical habitat for both the survival and the recovery of the listed species (50 CFR Section 402.02). For those ESUs without designated critical habitat, NMFS will evaluate the effects of the proposed action on the essential features of the species’ habitat to determine whether the action is likely to jeopardize the species’ continued existence.

Quantitatively defining a level of adequacy through specific, measurable standards is difficult for many of these biological requirements. In many cases, the absolute relationship between the critical element and species survival is not clearly understood, thus limiting development of specific, measurable standards. In contrast, some parameters are generally well known in the fisheries literature (e.g., thermal tolerances). For the remaining action-area biological requirements, the effects of any adverse impacts on essential habitat features are considered in more qualitative terms.

## **3.3 Factors Affecting Species’ Environment in Action Area**

### **3.3.1 Hydrosystem Effects**

Columbia River basin anadromous salmonids, especially those above Bonneville Dam, have been dramatically affected by the development and operation of the FCRPS. Storage dams have eliminated spawning and rearing habitat and have altered the natural hydrograph of the Snake and Columbia rivers, decreasing spring and summer flows and increasing fall and winter flows. Power operations cause fluctuation in flow levels and river elevations, affecting fish movement through reservoirs and riparian ecology and stranding fish in shallow areas. The eight dams in the migration corridor of the Snake and Columbia rivers alter smolt and adult migrations. Smolts experience a high level of mortality passing through the dams. The dams also have converted the once-swift river into a series of slow-moving reservoirs, slowing the smolts’ journey to the ocean and creating habitat for predators. Water velocities throughout the migration corridor are now far more dependent on volume runoff than before development of the mainstem reservoirs.

There have been numerous changes in the operation and configuration of the FCRPS as a result of ESA consultations between the U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration and the NMFS and USFWS. The changes are expected to improve survival for the listed fish migrating through the Snake and Columbia rivers. Increased spill at all FCRPS dams allows smolts to avoid both turbine intakes and bypass systems. Increased flow in the mainstem Snake and Columbia rivers provides better inriver conditions for smolts. The transportation of smolts from the SR has also been improved by the

addition of new barges and modification of existing barges.

In addition to spill, flow, and transportation improvements, the Corps implemented numerous other improvements to project operations and maintenance at all Columbia and SR dams. These improvements, such as operating turbines at peak efficiency, new extended-length screens at McNary, Little Goose, and Lower Granite dams, and extended operation of bypass screens, are discussed in greater detail in the 2000 FCRPS Biological Opinion (NMFS 2000a).

It is possible to quantify the survival benefits accruing from these many actions for each of the listed ESUs. For SR spring/summer chinook smolts migrating inriver, the estimated survival through the hydrosystem is between 40% and 60%, compared with an estimated survival rate during the 1970s of 5% to 40%. SR steelhead have probably received a similar benefit because their life history and run timing are similar to that of spring/summer chinook (NMFS 2000b). It is more difficult to obtain direct data and compare survival improvements for fish transported from the SR, but there are likely to be improvements for transported fish as well. It is reasonable to expect that the improvements in operation and configuration of the FCRPS will benefit all listed Columbia basin salmonids and that the benefits will be greater the farther upriver the ESU. However, further improvements are necessary because the Federal hydrosystem continues to cause a significant level of mortality for some ESUs. NMFS recently completed a reinitiated consultation on the FCRPS (NMFS 2000a) and the related All-H paper (Federal Caucus 2000). These provide direction for the future configuration and operation of the FCRPS and a blue print for actions required in other sectors considered necessary for the survival and recovery of listed species.

Several non-Federal projects licensed by the Federal Energy Regulating Commission (FERC) also affect the 12 ESUs on the mainstem Columbia and Snake rivers. Many of the ESUs are also affected by FERC projects on smaller tributaries or other water development projects.

### **3.3.2 Habitat Effects**

The quality and quantity of freshwater habitat in much of the CRB have declined dramatically in the last 150 years. Forestry, farming, grazing, road construction, hydrosystem development, mining, and urbanization have radically changed the historical habitat conditions of the basin. With the exception of fall chinook, which generally spawn and rear in the mainstem, salmon and steelhead spawning and rearing habitat is found in tributaries to the Columbia and Snake rivers. Anadromous fish typically spend from a few months to 3 years rearing in freshwater tributaries. Depending on the species, they spend from a few days to 1 or 2 years in the CR estuary before migrating out to the ocean and another 1 to 4 years in the ocean before returning as adults to spawn in their natal streams. Thirty-two subbasins provide spawning and rearing habitat.

Water quality in streams throughout the CRB has been degraded by human activities such as dams and diversion structures, water withdrawals, farming and grazing, road construction, timber harvest activities, mining activities, and urbanization. Over 2,500 streams and river segments and lakes do not meet Federally approved, state and tribal water quality standards and

are now listed as water quality limited under Section 303(d) of the CWA. Tributary water quality problems contribute to poor water quality where sediment and contaminants from the tributaries settle in mainstem reaches and the estuary.

Most of the water bodies in Oregon, Washington, and Idaho that are on the 303(d) list do not meet water quality standards for temperature. Temperature alterations affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and smoltification. Many factors can cause high stream temperatures, but they are primarily related to land-use practices rather than point-source discharges. Some common actions that result in high stream temperatures are the removal of trees or shrubs that directly shade streams, excessive water withdrawals for irrigation or other purposes, and warm irrigation return flows. Loss of wetlands and increases in groundwater withdrawals have contributed to lower base-stream flows, which in turn contribute to temperature increases. Channel widening and land uses that create shallower streams also cause temperature increases.

Pollutants also degrade water quality. Salmon require clean gravel for successful spawning, egg incubation, and emergence of fry. Fine sediments clog the spaces between gravel and restrict the flow of oxygen-rich water to the incubating eggs. Excess nutrients, low levels of dissolved oxygen, heavy metals, and changes in pH also directly affect the water quality for salmon and steelhead.

Water quantity problems are also a significant cause of habitat degradation and reduced fish production. Millions of acres of land in the basin are irrigated. Although some of the water withdrawn from streams eventually returns as agricultural runoff or groundwater recharge, crops consume a large proportion. Withdrawals affect seasonal flow patterns by removing water from streams in the summer (mostly May through September) and restoring it to surface streams and groundwater in ways that are difficult to measure. Withdrawing water for irrigation, urban, and other uses can increase temperatures, smolt travel time, and sedimentation. Return water from irrigated fields can introduce nutrients and pesticides into streams and rivers.

On a larger landscape scale, human activities have affected the timing and amount of peak water runoff from rain and snowmelt. Forest and range management practices have changed vegetation types and density, which can affect timing and duration of runoff. Many riparian areas, flood plains, and wetlands that once stored water during periods of high runoff have become developed. Urbanization paves over or compacts soil and increases the amount and pattern of runoff reaching rivers and streams.

Many tributaries have been significantly depleted by water diversions. In 1993, fish and wildlife agency, tribal, and conservation group experts estimated that 80% of 153 Oregon tributaries had low-flow problems (two-thirds caused at least in part by irrigation withdrawals) (Oregon Water Resources Department 1993). The NWPPC showed similar problems in many Idaho, Oregon, and Washington tributaries (NWPPC 1992).

Blockages that stop the downstream and upstream movement of fish exist at many agricultural, hydrosystem, municipal/industrial, and flood control dams and barriers. Highway culverts that are not designed for fish passage also block upstream migration. Migrating fish are diverted into unscreened or inadequately screened water conveyances or turbines, resulting in unnecessary mortality. While many fish-passage improvements have been made in recent years, manmade structures continue to block migrations or kill fish throughout the basin.

Land ownership has played a part in habitat and land use changes. Federal lands, which compose 50% of the basin, are generally forested and influence upstream portions of the watersheds. While there is substantial habitat degradation across all ownerships, in general, habitat in many headwater stream sections is in better condition than in the largely non-Federal lower portions of tributaries (Doppelt et al. 1993, Frissell 1993, Henjum et al. 1994, Quigley and Arbelbide 1997). In the past, valley bottoms were among the most productive fish habitats in the basin (Stanford and Ward 1992, Spence et al. 1996, ISG 1996). Today, agricultural and urban land development and water withdrawals have significantly altered the habitat for fish and wildlife. Streams in these areas typically have high water temperatures, sedimentation problems, low flows, simplified stream channels, and reduced riparian vegetation.

Mainstem habitats of the Columbia, Snake, and Willamette rivers have been affected by impoundments that have inundated large amounts of spawning and rearing habitat. Historically, fall chinook salmon spawned in the mainstem near The Dalles, Oregon, upstream to the Pend Oreille River in Washington and the Kootenai River in Idaho, in the SR downstream of Shoshone Falls, and upstream from the mouth of the SR to Grand Coulee Dam. Current mainstem production areas for fall chinook are mostly confined to the Hanford Reach of the mid-Columbia River and to the Hells Canyon Reach of the SR, with minor spawning populations elsewhere in the mid-Columbia, below the lower SR dams, and below Bonneville Dam. Hanford Reach is the only known mainstem spawning area for steelhead. Chum salmon habitat in the lower Columbia may also have been inundated by Bonneville Reservoir. Mainstem habitat in the Columbia, Snake, and Willamette rivers has been reduced, for the most part, to a single channel, floodplains have been reduced in size, off-channel habitat features have been lost or disconnected from the main channel, and the amount of large woody debris (large snags/log structures) in rivers has been reduced. Most of the remaining habitats are affected by flow fluctuations associated with reservoir management.

The CR estuary has also been changed by human activities. Historically, the downstream half of the estuary was a dynamic environment with multiple channels, extensive wetlands, sandbars, and shallow areas. The mouth of the CR was about 4 miles wide. Winter and spring floods, low flows in late summer, large woody debris floating downstream, and a shallow bar at the mouth of the CR kept the environment dynamic. Today, navigation channels have been dredged, deepened and maintained, jetties and pile-dike fields have been constructed to stabilize and concentrate flow in navigation channels, marsh and riparian habitats have been filled and diked, and causeways have been constructed across waterways. These actions have decreased the width of the mouth of the CR to 2 miles and increased the depth of the CR channel at the bar from less than 20 to more than 55 feet. Sand deposition at river mouths has extended the Oregon coastline

approximately 4 miles seaward and the Washington coastline approximately 2 miles seaward (Thomas 1981).

More than 50% of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses. More than 3,000 acres of intertidal marsh and spruce swamps have been converted to other uses since 1948 (Lower Columbia River Estuary Program 1999). Many wetlands along the shore in the upper reaches of the estuary have been converted to industrial and agricultural lands after levees and dikes were constructed. Furthermore, water storage and release patterns from reservoirs upstream of the estuary have changed the seasonal pattern and volume of discharge. The peaks of spring/summer floods have been reduced, and the amount of water discharged during winter has increased.

Studies begun in 1997 by the Oregon Cooperative Fish and Wildlife Research Unit, the USGS, and CRITFC have shown that fish-eating birds that nest on islands in the CR estuary (Caspian terns, double-crested cormorants, and glaucous-winged gulls) are significant avian predators of juvenile salmonids. Researchers estimated that the tern population on Rice Island (16,000 birds in 1997) consumed 6 to 25 million outmigrating smolts during 1997 (Roby et al. 1998) and 7 to 15 million during 1998 (Collis et al. 1999). The observed levels of predation prompted the regional fish and wildlife managers to investigate the feasibility of management actions to reduce the impacts. Early management actions appear to have reduced predation rates; researchers estimate that terns consumed 7.3 million smolts during 1999 (Columbia Basin Bird Research 2000). Because Rice Island is a dredged material disposal site in the CR estuary, created by the Corps under its Columbia River Channel Operation and Maintenance Program, the effects of tern predation on the survival and recovery of listed salmonids are considered in a separate consultation on that program. This factor is considered part of the environmental baseline on effects of the FCRPS.

The All-H Paper outlines a broad range of current habitat programs. Because most of the basin's anadromous fish spawning habitat is in Federal ownership, Federal land management programs are of primary importance. Current management is governed by an ecosystem-based aquatic habitat and riparian-area management strategy known as PACFISH, and associated biological opinions. This interim strategy covers the majority of the basin accessible to anadromous fish and includes specific prescriptions designed to halt habitat degradation.

The All-H Paper also outlines a large number of non-Federal habitat programs. However, because non-Federal habitat is managed predominantly for private rather than public purposes, expectations for non-Federal habitat are harder to assess. Degradation of habitat for listed fish from activities on non-Federal lands is likely to continue to some degree over the next 10 years, although at a reduced rate due to state, tribal, and local recovery plans.



### 3.3.3 Hatchery Effects

For more than 100 years, hatcheries in the Pacific Northwest have been used to replace natural production lost as a result of the FCRPS and other development, not to protect and rebuild natural populations. As a result, most salmon populations in this region are primarily hatchery fish. In 1987, for example, 95% of the coho, 70% of the spring chinook, 80% of the summer chinook, 50% of the fall chinook, and 70% of the steelhead returning to the Columbia Basin originated in hatcheries (Columbia Basin Fish and Wildlife Authority 1990).

While hatcheries certainly have contributed greatly to the overall numbers of salmon, only recently has the effect of hatcheries on native wild populations been demonstrated. In many cases, these effects have been substantial. For example, production of hatchery fish, among other factors, has contributed to the 90% reduction in wild coho salmon runs in the lower CR over the past 30 years (Flagg et al. 1995). Hatcheries have traditionally focused on providing fish for harvest, with less attention given to identifying and resolving factors causing declines of native runs.

NMFS has identified four primary categories of risk that hatcheries can pose on wild-run salmon and steelhead: 1) ecological effects, 2) genetic effects, 3) overharvest effects, and 4) masking effects (Federal Caucus 2000). Ecologically, hatchery fish can increase predation on, displace, and/or compete with wild fish. These effects are likely to occur when fish are released in poor condition and do not migrate to marine waters, but rather remain in the streams for extended rearing periods, during which they may prey on or compete with wild fish. Hatchery fish also may transmit hatchery-borne diseases, and hatcheries themselves may release diseases into streams via water effluents.

Genetically, hatchery fish can affect the genetic variability of native fish via interbreeding, either intentionally or accidentally. Interbreeding can also result from the introduction of native stocks from other areas. Theoretically, interbred fish are less adapted to and productive within the unique local habitats where the original native stock evolved.

In many areas, hatchery fish provide increased fishery opportunities. When wild fish mix with hatchery stock, fishing pressure can lead to overharvest of smaller or weaker wild stocks. Further, when migrating adult hatchery and wild fish mix on the spawning grounds, the health of the wild runs and the condition of the habitat's ability to support runs can be overestimated, because the hatchery fish mask surveyors' ability to discern actual wild run conditions.

NMFS determined that there is an need for immediate hatchery reform and conservation actions (Federal Caucus 2000). Federal agencies have worked with the NWPPC to initiate the reform measures from the hatchery biological opinions and related actions that should proceed during the first three years of the FCRPS implementation. Such reforms are being pursued in the context of the Hatchery and Genetic Management Plans (HGMP). The HGMP is a tool for defining goals and objectives of a particular hatchery, and its relationship to prioritized basin objectives, including harvest opportunities and wild stock performance. Specifically, each

HGMP should ensure that genetic broodstock selected is appropriate, that it minimizes the potential for adverse ecological effects on wild populations, and that it is integrated into basin-wide strategies to meet objectives of all H's. A phased work plan for developing the HGMPs has been developed. The phase 1 HGMPs are scheduled for completion in the fall of 2002.

### **3.3.4 Harvest Effects**

#### **3.3.4.1 Ocean Harvest**

##### **Chinook Salmon**

###### Snake River Fall Chinook

Although consultation related to PFMC salmon fisheries and those that occur in Southeast Alaska and Canada are considered in separate biological opinions, ocean fisheries in general have all been subject in recent years to the same ocean exploitation rate (ER) limit for SR fall chinook. The combined ocean fisheries are required to achieve a 30% reduction in the average 1988-93 base period ER on SR fall chinook (Lohn and McInnis 2002).

In recent years, there have been substantial reductions ocean fisheries in general, and in Canadian fisheries in particular. As a result, the ER reduction for combined ocean fisheries has met and exceeded the prescribed standard for SR fall chinook. The base period reduction in combined ocean fisheries has averaged 54% since 1996. The expected base period reduction for the combined 2002 ocean fisheries is 53% (PFMC 2002b). The 1996-2001 average annual total adult equivalent exploitation rates for SR fall chinook 44% (Table 8)

###### Lower Columbia River Chinook

The LCR chinook ESU includes spring, tule, and bright components. The spring component of the LCR ESU will not be affected by the fall season fisheries being considered as part of this proposed action. The expected ER on tule stocks is 35% for all ocean fisheries combined and 45% overall including the inriver fisheries. The total ER for 2002 will thus be below the 49% ER limit specified by NMFS (Lohn and McGinnis 2002). The ocean ER on LCR bright stocks is generally lower. The expected ocean escapement of the North Fork Lewis indicator stock is 18,300 compared to an escapement goal of 5,700. The 1996-2001 average annual total adult ER rates for LCR tule stocks is 36% (Table 8). The 1996-2001 average annual total adult equivalent exploitation rates for LCR bright stocks is 23% (Table 8).

##### **Steelhead**

Steelhead are rarely caught in ocean fisheries and therefore ocean harvest is not considered a significant source of mortality to any of the listed steelhead ESUs considered in this opinion (Lohn and McInnis 2002). The 1998-2001 average inriver tribal harvest rate for natural-origin B-run SR steelhead is 12.6% (Table 8). This represents a 51% reduction over the 1985-97 average inriver harvest rate for natural-origin B-run SR steelhead of 25.9% (Table 8).

## **Chum Salmon**

Chum salmon are not caught in ocean salmon fisheries off the Washington, Oregon, and California coast managed by the Pacific Fishery Management Council (PFMC) (NMFS 2001a). There are fisheries directed at chum in Puget Sound and in Canada and Alaska that generally target maturing fish returning to nearby terminal areas in the fall. We have no specific information on the ocean distribution of CR chum salmon, but given the timing and distant location of fisheries directed at chum, it is unlikely that CR chum are significantly affected by ocean fisheries.

### **3.3.4.2 Columbia Basin Harvest**

There is some harvest to listed species considered in the opinion that occurs within the action area, but outside the scope of the proposed fall season fisheries. This includes Indian and non-Indian harvest during the 2001 winter, spring, and summer season fisheries covered under an earlier biological opinion (NMFS 2001b), and tributary recreational fisheries that are being considered separately under section 4d of the ESA. The harvest rates associated with these fisheries are summarized in Table 9

## **3.4 Natural Conditions**

Changes in the abundance of salmonid populations are substantially affected by changes in the freshwater and marine environments. For example, large-scale climatic regimes, such as El Niño, affect changes in ocean productivity. Much of the Pacific Coast was subject to a series of very dry years during the first part of the 1990s. In more recent years, severe flooding has adversely affected some stocks. For example, the low return of Lewis River bright fall chinook salmon in 1999 is attributed to flood events during 1995 and 1996.

Chinook salmon are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although the levels of predation are largely unknown. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, has resulted in substantial mortality for salmonids. In recent years, for example, sea lions have learned to target UWR spring chinook salmon in the fish ladder at Willamette Falls. In some locations sea lions and harbor seals have learned to pull fish trapped in gillnets before they can be landed.

A key factor substantially affecting many West Coast stocks has been the general pattern of a 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood. The pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of coded-wire tag

(CWT) recoveries of subadults relative to the number of CWTs released from that brood year.

<b>Table 8.</b> Annual total adult equivalent exploitation rates (ocean and inriver fisheries combined) for selected CR fall chinook stocks and inriver treaty Indian harvest rates for SR A and B-run steelhead.					
Return Year	Snake River Fall Chinook	Lower Columbia River tules (Coweeman River)	Lower Columbia River brights (North Fork Lewis River)	Snake River A-run Steelhead	Snake River B-run Steelhead
1980	64%	85%	70%		
1981	66%	75%	41%		
1982	62%	75%	46%		
1983	68%	64%	42%		
1984	77%	74%	58%		
1985	72%	60%	56%	20.7%	31.0%
1986	77%	72%	66%	13.8%	26.8%
1987	75%	79%	66%	15.7%	37.20%
1988	83%	86%	71%	17.1%	23.5%
1989	77%	69%	45%	15.9%	35.0%
1990	79%	67%	40%	16.0%	21.5%
1991	67%	68%	58%	14.7%	30.0%
1992	63%	67%	59%	16.2%	26.3%
1993	65%	61%	52%	15.2%	19.2%
1994	50%	36%	41%	10.3%	18.7%
1995	44%	34%	38%	10.4%	18.4%
1996	38%	26%	18%	9.0%	35.0%
1997	50%	38%	31%	10.4%	14.3%
1998	42%	30%	21%	8.8%	15.5%
1999	48%	45%	19%	7.9%	9.9%
2000	47%	39%	24%	4.7%	13.3%
2001	40%	36%	28%	4.0%	11.5%
mean 80-95	68%	67%	53%		
mean 96-01	44%	36%	23%		
mean 85-97				14.3%	25.9%
mean 98-01				6.4%	12.6%

**Table 9.** Expected harvest rates to listed salmonids that will occur within the action area, but outside the scope of proposed fall season fisheries. Included are impacts to listed salmonids in 2002 CRB winter, spring, and summer season fisheries. Also shown are impacts associated with tributary recreational steelhead fisheries. (NA - estimates not available.)

ESU	Non-Indian fisheries		Treaty Indian fisheries
	(wtr/spr/sum)	Tributary fisheries	(wtr/spr/sum)
Lower Columbia River chinook	1.7% <sup>a</sup>	NA	0
Snake River steelhead			
A-run	0.2%	2.5% <sup>c</sup>	2.7% <sup>b</sup>
B-run	0	2.5% <sup>c</sup>	<sup>b</sup>
Upper Columbia River steelhead			
Naturally-produced	0.6%	0	3.8%
Hatchery-produced	4.5%	0	2.7%
Mid-Columbia River steelhead	<2.0% <sup>d</sup>	NA	3.6%
Lower Columbia River steelhead	<2.0% <sup>d</sup>	NA	1.6%
Columbia River chum	0	<sup>e</sup>	0
Snake River sockeye	<1.0%	0	<7.0%
<sup>a</sup> Spring component of the LCR ESU only. <sup>b</sup> B-run steelhead of the current return year are primarily caught in fall season fisheries. However, a portion of the summer steelhead run holds over in the LCR above Bonneville dam until the following winter and spring; these fish, thought to be mostly A-run, are caught in fisheries in those seasons. <sup>c</sup> Maximum harvest rate applied to wild fish passing through terminal fishery areas where hatchery fish are being targeted; hooking mortality of 5% applied to an assumed 50% encounter rate. Harvest rates to stocks not passing through targeted terminal fishing areas will be less. <sup>d</sup> Preseason impacts limits; postseason estimates not yet available. <sup>e</sup> Chum may be taken occasionally in tributary fisheries below Bonneville Dam. Retention is prohibited.			

Time series of survival rate information for UWR spring chinook, Lewis River fall chinook salmon show highly variable or declining trends in early ocean survival, with very low survival rates in recent years (NMFS 2001a). Recent evidence suggests that marine survival of salmonids fluctuates in response to 20- to 30-year long periods of either above or below average survival that is driven by long-term cycles of climatic conditions and ocean productivity (Cramer et al. 1999). This has been referred to as the Pacific Decadal Oscillation (PDO). It is apparent that ocean conditions that affect the productivity of Northwest salmon populations have been in a low

phase of the cycle for some time. The variation in ocean conditions has been an important contributor to the decline of many stocks. However, the survival and recovery of the species depends on their ability to persist through periods of low ocean survival when stocks may depend on better quality freshwater habitat and lower relative harvest rates.

Recent information suggests that ocean conditions may have undergone a substantive change beginning in 1999 as indicated by cooler ocean temperatures, changes in species composition of zooplankton, fewer pelagic predators such as hake and mackerel, and the increased abundance of bait fish (B. Emmett, NMFS, pers. comm., w/ P. Dygert, NMFS, June 7, 2001). The most relevant indicator to this consultation has been the unprecedented return of upriver spring chinook over the last two years. The return in 2001 of over 400,000 upriver spring chinook to the CR is the highest return by far since counts began at Bonneville Dam in 1938. The return in 2002 of nearly 300,00 upriver spring chinook was the second highest return on record. The return of upriver summer steelhead in 2001 was more than twice the next highest return seen since at least 1984 with another strong return expected in 2002. The return of upriver fall chinook in 2001 was the highest observed since the peak years in the mid-80. An even larger return is expected in 2002. It is apparent the benefits of improved ocean conditions do not uniformly affect all stocks in all years. Coho and sockeye returns to the Columbia River were very strong in 2001, but are expected to be much lower in 2002.

In contrast, the extraordinary drought conditions in 2001 will likely adversely affect future return. The available water in the upper CRB was 50-60% of normal and resulted in some of the lowest flow conditions on record. It is reasonable to expect that these conditions will have the greatest effect on upriver stocks that migrated through the mainstem Columbia and Snake rivers past many dams. The juveniles that passed down river during the 2001 spring and summer out-migration will likely be significantly affected. At this point it is too early to tell how the apparent change in ocean survival and poor out-migration conditions in 2001 will interact to affect returns after 2002. The low expected return of coho in 2002 may be related to more depressed conditions in the immediate area of the Columbia River plume due to low flows. The poor out migration conditions are more likely to effect chinook and steelhead stocks returning in 2003 and 2004. However, because of the low flow conditions, an effort was made to trap and transport as many of the smolts as possible. Approximately 90% of Snake River steelhead smolts were collected and transported. As a result, returns in the next few years will likely depend more on the survival rates of transported fish than the survival of smolts which migrated inriver.

Based on currently available information, it is reasonable to conclude that the combined effect of all of the H's and changing survival conditions has led to the decline and resulting current status of the species of concern. In this opinion, NMFS focuses on harvest, in the context of the environmental baseline and the current status of the species. Although harvest can be reduced in response to the listed species' depressed status and the reduced productivity that results from the degradations related to other human activities, the recovery of the listed species depends on improving the productivity of the natural populations in the wild. These improvements can only be made by addressing the factors of decline related to all of the H's that will be the subject of future opinions and recovery planning efforts.

### **3.5 Expected Future Performance**

Most ESUs in the Columbia Basin are expected to experience improved survivals as a result of improvements in FCRPS operations and configuration, habitat improvements on Federal and other lands, improvements in hatchery practices, and improvements in harvest measures. Notwithstanding these improvements, however, is the fact that environmental conditions are still generally quite poor with respect to salmonid survival in a number of their life phases. In fact, for many stocks, survivals must improve by an order of magnitude in order for the ESUs to survive and recover. The long-term survival of many ESUs from the upper and mid-Columbia Basin will depend upon improvements in ocean and habitat conditions, hatchery practices, and conditions in the hydropower corridor. For lower Columbia Basin stocks, long-term survival and recovery will depend more on improvements in ocean conditions and habitat, and hatchery practices. For the chinook and steelhead ESUs considered in this opinion, harvest has generally been reduced to the point that it is not a major factor limiting recovery of Columbia Basin stocks. Nevertheless, harvest reductions will continue to be a necessary and important contributor to the species' survival through the current bottleneck, and may require further refinement to insure that they continue to be managed consistent with the annually changing status of the stocks.

### **4.0 EFFECTS OF THE ACTION**

The standards for determining jeopardy are set forth in Section 7(a)(2) of the ESA and in 50 CFR §402.02. This, and the following sections of the Biological Opinion, apply those standards in determining whether the proposed fisheries are likely to jeopardize the continued existence of one or more of the threatened or endangered salmon species (ESUs) that may be adversely affected by the fisheries. This analysis considers the direct, indirect, interrelated and interdependent effects of the proposed fisheries and compares them against the Environmental Baseline to determine if the proposed fisheries will appreciably reduce the likelihood of survival and recovery of these listed salmon in the wild.

The jeopardy determinations in this opinion are also based on specific consideration of the magnitude and duration of harvest reductions made to date, the proposed management actions taken to reduce the catch of listed fish, the magnitude of the remaining harvest, particularly in comparison to the period of decline, and available risk assessment analyses. Where pertinent, NMFS reviewed the consideration and decisions made during past consultations on these same fall season fisheries. In general, NMFS sought to develop analyses that considered the status of the species, the environmental baseline, and the effects of the proposed actions, particularly within the context of other harvest activities that are likely to affect the species. NMFS considered the population structure of each ESU when appropriate by reviewing both the status and impacts to components that were considered representative or important to the ESU as a whole. NMFS also considered the analysis and assumptions contained in the recent All-H paper (Federal Caucus 2000 ) and associated FCRPS opinion (NMFS 2000a). These provided a broader context for considering the impacts associated with a particular action, including those related to harvest, than we have had prior to completion of the FCRPS opinion. In general, the analysis contained in the FCRPS opinion assumed that harvest rates would be held at or below the already-

reduced levels outlined in NMFS' most recent biological opinions for the foreseeable future. For the critical stocks considered in this opinion this effectively capped future harvest rates at recent levels thus providing a benchmark against which to evaluate other proposed actions.

#### **4.1 Effects on Critical Habitat and Essential Habitat Features**

Critical habitat has been designated for SR fall chinook. As discussed in section 2.1, critical habitat designations for the other affected ESUs have been vacated pending further rule making by NMFS. Nonetheless, the essential habitat features for the affected ESUs are described in the Environmental Baseline section of this opinion. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the following analyses regarding harvest related mortality. Most of the harvest related activities occur from boats or along river banks. Gears that are used include primarily hook-and-line, drift and set gillnets, and hoop nets that do not substantially affect the habitat. There will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality. Thus there will be minimal effects on the essential habitat features of the affected species from the actions discussed in this opinion, certainly not enough to contribute to a decline in the values of the habitat.

Coho salmon that may be affected by the actions reviewed in this opinion are not listed under the ESA, and are therefore not considered as part of the ESA consultation. However, the effects of the action on essential fish habitat (EFH) of coho are considered as part of the associated Magnuson-Stevens Act EFH consultation that is incorporated at the end of this opinion. The description of essential habitat features included in the Environmental Baseline section, and the conclusions regarding the likely effects on habitat features described above, are general and apply to coho as well.

#### **4.2 Factors to Be Considered**

Fisheries may affect salmonid ESUs in several ways which have bearing on the likelihood of continued survival of the species. Immediate mortality effects accrue from the hooking or netting and subsequent retention of individual fish — those effects are considered explicitly in this opinion.

In addition, mortalities may occur to any fish which is caught and released. This is important to consider in the development of fishery management actions, as catch-and-release mortalities primarily result from implementation of management regulations designed to reduce mortalities to listed fish through live release. The catch-and-release mortality rate varies for different gear types, different species, and different fishing conditions, and those values are often not well known. Catch-and-release mortality rates have been estimated from available data and applied by TAC in the calculation of impacts to fish listed and proposed for listing evaluated in this consultation. The TAC applies a 10% incidental mortality rate to salmon caught and released during recreational fishing activities. The TAC also applies a 1% incidental mortality rate to salmon caught and released using dipnets. In the absence of data on catch-and-release mortalities



in other fisheries considered in this opinion, TAC applies the same 10% mortality rate to all other fisheries practicing live release. Estimates of catch-and-release mortality are combined with landed catch estimates when reporting the expected total mortality, and so are also specifically accounted for in this opinion.

The states and tribes propose to manage their fisheries subject to various harvest rate caps for individual ESUs or ESU components. In some cases the parties presume that the fisheries will be managed up to the specified limit. In other cases there are differences between the harvest rate cap and the expected harvest rate. For example, SR fall chinook are considered the limiting stock, and fisheries are likely to be managed up to the 31.29% harvest rate limit. Alternatively, the states propose to manage their fisheries subject to a 2% harvest rate limit on natural-origin steelhead. However, the expectation is that the chinook limit will be reached before the steelhead limit is reached. The expected harvest rate on A-run steelhead for each of the ESUs is generally less than 2% (Table 10). In discussing the effects of the action, a distinction is therefore made, where appropriate, between a proposed harvest rate cap and the expected harvest rate resulting from the proposed fishery.

### **4.3 Effects of the Proposed Action**

#### **4.3.1 Chinook Salmon**

The states and tribes propose fisheries with several management objectives that are described in the biological assessment (LeFleur 2002) and the associated 2002 Management Agreement (U.S. v Oregon Parties 2002). The state and tribal parties propose to manage their fisheries subject to a harvest rate cap of 31.29% on Snake River fall chinook. This harvest rate represents a 30% reduction in the harvest rate relative to the 1988-93 base period. The parties have further agreed to allocate the harvest rate cap 8.25% to non-Indian fisheries and 23.04% to tribal fisheries.

The fall tribal fisheries are not likely to affect any of the components of the LCR ESU which return primarily to tributaries below Bonneville Dam. The proposed state fisheries are not likely to affect the spring component of the LCR ESU. The expected non-Indian harvest rate on LCR tule stocks in the proposed fisheries is 16.4% (Table 10). Additionally, NMFS has developed a combined ocean/freshwater Adult Equivalent (AEQ) Rebuilding Exploitation Rate (RER) of 49% based on the Coweeman tule population. NMFS previously provided guidance to the PFMC indicating that ocean and inriver fisheries should be managed such that the total exploitation rate from all fisheries does not exceed 49% (Lohn and McInnis 2002). Using the AEQ exploitation rate from the Washington component of the LRH stock as a surrogate for the exploitation rate on naturally spawning tule fall chinook yields a combined ocean/freshwater AEQ exploitation rate of 45.4% (34.7% ocean and 10.7% freshwater, see Table 10 in the BA). There may be some confusion in comparing an inriver harvest rate and the freshwater component of a total exploitation rate. In this case, the 16.4% harvest rate is equivalent to a 10.7% exploitation rate. Consistent with NMFS earlier guidance, NMFS expects that the inriver fisheries will be managed subject to the 49% total AEQ exploitation rate.

The North Fork Lewis River population is used as an indicator for managing bright stocks in the LCR ESU. As indicated in the earlier discussion regarding the status of the species (see section 2.3), the Lewis River bright stock has consistently met or exceeded its escapement goal of 5,700. The parties propose to manage the fishery to meet the escapement goal. The expected inriver harvest rate on the Lewis River stock is 7.5% with an expected escapement of 12,700 (Table 10).

#### **4.3.2 Steelhead**

The LCR and MCR steelhead ESUs include both winter and summer-run stocks. Because of their timing, fall season fisheries affect only summer-run steelhead. Winter-run steelhead returning to the LCR, and MCR ESUs are therefore unaffected by the proposed fall season fisheries.

The tribes propose to manage their fisheries subject to a 15% harvest rate limit on natural-origin Snake River Group B Index steelhead (LeFleur 2002, U.S. v Oregon Parties 2002). The expected incidental harvest rates on natural-origin SR A and B-run steelhead associated with the proposed tribal fisheries are 4.7% and 14.9%, respectively (Table 10).

Summer steelhead returning to the other ESUs are all A-run fish. The expected harvest rate in tribal fisheries on UCR steelhead is 5.0% and 6.7% for the listed natural-origin and hatchery-origin fish, respectively. The expected harvest rate on natural-origin MCR and LCR steelhead are 3.9% and 1.0%, respectively (Table 10).

The states proposed to manage their fisheries subject to a 2% harvest rate limit for all natural-origin steelhead. The expected harvest rates associated with the states' proposed fisheries are actually less than the proposed 2% cap and vary slightly by ESU. The expected harvest rates for natural-origin UCR, SR A and B-run, MCR, and LCR are 1.5%, 0.7%, 1.7%, 1.0%, and 0.3%, respectively. The expected harvest rate on listed hatchery-origin steelhead from the UCR ESU is 12.4% (Table 10).

#### **4.3.3 Chum Salmon**

Chum salmon are not caught in tribal fisheries since the remaining populations are all located below Bonneville Dam.

Retention of chum salmon in state recreational fisheries is prohibited. The catch of chum is relatively rare in any case since chum do not actively take sport gear generally used to target other species. Impacts in the recreational fishery are from non-retention mortalities and are expected to be zero fish in 2002 (LeFleur 2002).

The migration timing of chum salmon is late enough that they are missed by most of the states' lower river commercial fisheries. There is some incidental catch during fisheries in late September and October directed primarily at coho. Commercial landings of chum have averaged 49 fish since 1995. TAC estimated that the total harvest rate would be less than 1.6% (Table 10),

well below the proposed 5% harvest rate limit. TAC further indicated that the harvest rate projection was likely a maximum value since it is based on a minimum estimate of run size.

**Table 10.** Harvest rates on listed salmonids in proposed 2002 fall season fisheries in the CRB by ESU.

ESU	Non-Indian fisheries	Treaty Indian fisheries	Total
Snake River fall chinook	8.25% <sup>a</sup>	23.04% <sup>a</sup>	31.29% <sup>a</sup>
Lower Columbia River chinook			
Spring component	0% <sup>a</sup>	0%	0%
Tule component	16.4% <sup>a</sup>	0%	16.4% <sup>a</sup>
Bright component	7.5% <sup>b</sup>	0%	7.5% <sup>a</sup>
Snake River steelhead			
A-run	≤2% (0.7%) <sup>b</sup>	4.7% <sup>a</sup>	6.7% (5.4%) <sup>b</sup>
B-run	≤2% (1.7%) <sup>b</sup>	15% (14.9%) <sup>b</sup>	17% (16.6%) <sup>b</sup>
Upper Columbia River steelhead			
Natural-origin	≤2% (1.5%) <sup>b</sup>	5.0% <sup>a</sup>	7.0% (6.5%) <sup>b</sup>
Hatchery-origin	≤15% (12.4%) <sup>b</sup>	6.7% <sup>a</sup>	21.7% (19.1%) <sup>b</sup>
Mid-Columbia River steelhead	≤2% (1.0%) <sup>b</sup>	3.9% <sup>a</sup>	5.9% (4.9%) <sup>b</sup>
Lower Columbia River steelhead	≤2% (0.3%) <sup>b</sup>	1.0% <sup>a</sup>	3.0% (1.3%) <sup>b</sup>
Columbia River chum	5% (1.6%) <sup>b</sup>	0%	5% (1.6%) <sup>b</sup>
Snake River sockeye	0%	0%	0%

<sup>a</sup> Expected harvest rates.

<sup>b</sup> Maximum proposed harvest rates with the actual expected harvest rates associated with the proposed fisheries shown in parenthesis.

## 5.0 CUMULATIVE EFFECTS

Cumulative effects are those effects of future tribal, state, local or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. For the purpose of this analysis, the action area is that part of the CRB described in section 1.2 above. Future Federal actions, including the ongoing operation of hydropower systems, hatcheries, fisheries, and land management activities will be reviewed through separate section 7 consultation processes. Non-Federal actions that require authorization under section 10 of the ESA, and that are not included within the scope of this consultation, will be evaluated in separate section 7

consultations.

Future tribal, state and local government actions will likely to be in the form of legislation, administrative rules, or policy initiatives, and land use and other types of permits. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. These realities, added to geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and, frankly, speculative. For a more detailed discussion of representative actions that are reasonably certain to occur see NMFS' most recent consultation on the CR fall season fisheries (NMFS 2001c).

Non-federal actions on listed species are likely to continue affecting listed species. The cumulative effects in the action area are difficult to analyze considering the geographic landscape of this opinion, and the political variation in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in this section, the adverse cumulative effects are likely to increase. Although state, tribal and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

## **6.0 INTEGRATION AND SYNTHESIS OF EFFECTS**

### **6.1 Chinook Salmon**

#### **6.1.1 Snake River Fall Chinook**

SR fall chinook are expected to be the limiting stock in the fall season fisheries. In recent years, these fisheries have been subject to ESA limitations and required to reduce the harvest rate by 30% relative to the 1988-93 base period. This translates into an overall inriver harvest rate of 31.29%. The states and tribes again propose to manage their fisheries within the harvest rate limit, and allocate the 31.29% harvest rate between the proposed state and tribal fisheries - 8.25% and 23.04%, respectively.

NMFS first implemented the 30% base period reduction criterion as a standard for evaluating fall season fisheries in 1996 associated with its review of the 1996-1998 Fall Season Agreement (NMFS 1996b). The 1999 fall season opinion again (NMFS 1999b) reviewed the history and considerations used in developing the 30% base period reduction standard. As indicated, this standard was derived largely based on current status of knowledge regarding the level of harvest rate reduction that was necessary and sufficient to avoid appreciably reducing the likelihood of survival and recovery of the species in the wild. At the time, no quantitative analyses were available that could determine the effect of harvest impacts, in combination with other mortality

factors, on the likelihood of survival and recovery. It was clear, however, that the species had declined to low levels under the existing baseline conditions and that survival improvements were required across all sectors, including harvest. The 30% reduction, in combination with an analogous reduction in ocean fisheries, was considered a significant reduction to address, at least initially, the need for survival improvements given the current status of the stock. Incorporated into that consideration was a willingness to accept some increase in the risk to the species associated with higher harvest rates and fishery needs that were primarily related to the tribes' treaty fishing rights. The judgment made at the time was that the 30% base period reduction standard provided the appropriate balance without putting the species at undue risk. The standard was adopted in a biological opinion regarding the 1996-1998 Fall Season Agreement with the explicit provision that it would be reviewed and revised if necessary based on best available information (NMFS 1996b). In fact, in the 1999 opinion, NMFS removed a provision in the 1996-1998 Agreement that allowed for a higher harvest rate under certain conditions, and rejected a proposal that argued for a higher harvest rate based on new information which purportedly demonstrated an improvement in the status of the stock.

A further consideration in evaluating the status of SR fall chinook has been the existence of the Lyons Ferry Hatchery program which holds a substantial reservoir of fall chinook that are part of the ESU. Although hatchery fish are not a substitute for recovery, they do provide a further safeguard against catastrophes or continuing failures of the natural system that reduces the risk of species extinction. In this case, the Lyons Ferry Hatchery is used to maintain a brood stock, and is also used as a source for a very substantial supplementation program. The supplementation program has been scaled up over the last several years to provide both fingerling and yearling outplants that are acclimated and released in areas above LGD. The immediate objective of the supplementation program is to increase the number of natural-origin spawners. The return of adults to LGD from the supplementation program was 479 in 1998 and 882 in 1999 and 1,278 in 2000 and over 5,000 in 2001. This is in addition to the adults returning from natural production (see Table 3).

The return of fish from the supplementation program is not a substitute for recovery which depends on the return of self-sustaining populations in the wild. However, supplementation can be used to mitigate the risk of extinction by boosting the initial abundance of spawners while other actions are taken to increase the productivity of the system to the point where the population is self sustaining and supplementation is no longer required.

In considering the proposed 2002 fisheries it is also appropriate to review the magnitude of harvest reductions and the change in spawner escapements in recent years. The average harvest rate of SR fall chinook in the CR since 1996 is 27%, actually lower than the 31.29% limit. Taken from a broader perspective we can look at the combined impact of ocean and inriver fisheries and how that has changed over the last 20 years. The exploitation rate on SR fall chinook in the ocean and inriver fisheries combined has declined from an average of 68% from 1980-1995 to 44% since 1995 representing a 35% reduction in the overall exploitation rate (Table 8). The abundance of SR fall chinook has increased in recent years. The return of natural-origin chinook to LGD averaged 407 adults from 1980-1995 (range 78-742) including a low in 1990 of

just 78 fish. The average return to LGD from 1996-2000 was 700 (range 306-905, Table 3). In 2001 the return of natural-origin fish was nearly 6,800. We do not currently have a specific forecast for the return of natural-origin Snake River fall chinook for 2002. However, the forecast for URB chinook which includes SR fall chinook is 281,000 adults. This would be 64% greater than the recent 5-year average return and the fourth largest return since 1964 (PFMC 2002a) suggesting another strong return of Snake River fall chinook in 2002.

As discussed above, there has also been a substantial increase in the number of hatchery-origin fish from the SR fall chinook ESU including an escapement above LGD of over 5,000 Snake River origin fall chinook in 2001. There is no forecast yet for the return of hatchery-origin fish to LGD from the Lyons Ferry Hatchery and supplementation programs for 2002, but another strong return is expected based on the overall URB forecast and supplementation production levels from the applicable brood years.

These returns can be compared to the previously identified lower abundance threshold of 300 and recovery escapement goal of 2,500 which are the kinds of benchmarks suggested in the Viable Salmonid Populations paper (McElhany et.al., 1999) for evaluating populations status. NMFS has recently reaffirmed the use of 2,500 as an interim abundance target for SR fall chinook pending development of final recovery goals through the recovery planning process (Lohn 2002). Escapements in recent years have been well below goal, but also consistently above the lower abundance threshold. (This lower threshold is considered indicative of increased relative risk to a population in the sense that the further and longer a population is below the threshold the greater the risk; it was clearly not characterized as a “redline” below which a population must not go (BRWG 1994).) Returns in 2001 were substantially above the goal with another strong return expected in 2002. The increase in escapement can not be solely attributed to decreased harvest, but it does support the initial judgment that the prescribed harvest rates are consistent with survival and recovery.

For the SR fall chinook salmon ESU as a whole, NMFS estimates that the median population growth rate ( $\lambda$ ) over the base period ranges from 0.94 to 0.86 (Table 4). NMFS also estimated the risk of absolute extinction for the aggregate SR fall chinook salmon population, using the same range of assumptions about the relative effectiveness of hatchery fish. The estimated risk of extinction in 24 years is 0 regardless of assumptions related to hatchery fish. At the low end, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0), the risk of absolute extinction within 100 years is 0.40. At the high end, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%), the risk of absolute extinction within 100 years is 1.00. The risk of 90% decline in 100 years ranges from 0.96 to 1.00 (Table 4).

The CRI statistics are relatively pessimistic. The estimated  $\lambda$  values are less than one, indicating that the population is declining. If the population continues to decline over the long term, the analysis indicates that there is a high probability of extinction. However, it is important to recall that the CRI analysis is based on a certain set of years and the assumption that conditions would continue as they were during those base years. If factors affecting species survival change,

than the estimates of extinction risk will also change. Several factors suggest that circumstances have changed.

The CRI analysis for SR fall chinook relies on available abundance estimates from 1980 to 1996. It therefore characterizes recent trends and projects the future status of the ESU assuming that trends continue as they have during the base years. In fact, conditions have changed relative to the base years. The harvest rate has been reduced and there have been other improvements in both juvenile and adult passage conditions. Based on an analysis in the FCRPS opinion, the expected improvement in survival ranged from 49 to 86%. These in turn affect the estimates of lambda which now range from 0.97 to 1.07 (Table 9.7-7, NMFS 2000a). These estimates do not reflect the potential additional contribution of the supplementation program. Supplementation does not contribute to improvements in productivity or the rate of survival of natural-origin fish and so does not address the underlying problem. However, supplementation can increase the number of natural-origin spawners and therefore mitigates against the risk of extinction in the short term while additional measures taken to improve survival take effect.

This analysis suggests that harvest reductions and other actions taken to improve survival in recent years have contributed significantly in meeting the extinction risk reduction requirements. The analysis tends to confirm the qualitative considerations that suggest that harvest reductions made to date, including those in the CR fisheries, are consistent with expectations of survival and recovery and supports their continued use for 2002. Based on these considerations, NMFS concludes that the impacts associated with the proposed 2002 fisheries are not likely to appreciably reduce the likelihood of survival and recovery of SR fall chinook.

### **6.1.2 Lower Columbia River Chinook**

The spring component of LCR fall chinook are not harvested in the proposed fall season fisheries. Nearly all of the tule and bright stocks of the LCR ESU return to tributaries located below Bonneville Dam. LCR fall chinook are therefore largely unaffected by fall season tribal fisheries which do not extend below Bonneville.

As described in section 2.3.1.2 there are apparently four self-sustaining populations of tule chinook in the lower CR that are not currently substantially influenced by hatchery strays including those returning to the Coweeman, East Fork Lewis, Clackamas, and Sandy rivers. These are all relatively small stocks. The tule stock in the Clackamas was apparently reestablished after being substantially reduced or eliminated from in-basin hatchery production that occurred from 1952 to 1981 (Myers et al. 2002).

There is also some question whether the tule run in the Sandy was native or introduced from hatchery production (Myers et al. 2002). The average escapement on the Coweeman over the last five and ten years have been about 460 and 650, respectively, compared to an interim escapement goal of 1,000. These averages have been influenced substantially by the record escapements observed in 1996 and 1997 which ranged from 1,300 to 2,100 fish. From 1998 to 2000 escapements averaged about 120, but compare to escapements observed through much of

the data record since 1964. The escapement in 2001 was over 600. The return of earlier timed tules to the East Fork Lewis has been relatively stable and averaged about 160 over the last five years compared to an escapement goal in this relatively small system of 300. The escapement in 2001 was over 300. There are currently no goals for the Clackamas and Sandy where observed escapements have averaged about 50 and 160, respectfully in recent years.

In past years tule hatchery production was prioritized to support PFMC and Lower CR fisheries thus providing the potential for very high ERs on wild stocks. The tule stocks are north migrating, but are most vulnerable to catch in fisheries off the Washington coast, in West Coast Vancouver Island (WCVI) fisheries, and in the lower river. In recent years, ESA and other unrelated conservation constraints have substantially limited these fisheries, in particular, even though there have been no specific limits set for natural-origin tule stocks. The total adult equivalent (AEQ) exploitation rates (ER) for LCR tule chinook for all ocean and inriver fisheries combined averaged 67% for the 1980-1995 return years. ERs were likely even higher in earlier years. Since 1996 the total AEQ ER has averaged 36%, representing a 46% reduction in overall harvest (Table 8). The harvest from inriver fisheries accounted for about 32% of the total harvest mortality over the last six years. The inriver ER averaged 15% since 1996.

Escapement information from the Coweeman was used to estimate a rebuilding exploitation rate (RER) of 0.49 for natural origin tule stocks (Lohn and McInnis 2002). (See section 2.3 for background related to RERs.) In previous consultations NMFS used an RER of 0.65 to assess proposed fisheries (NMFS 2001c, Darm and Lent 2001). The RER was revised based on a more recent analysis of the data. Estimates of RERs are sensitive to assumptions about future survival. The survival rates for LCR tules have varied substantially over the years, but are without apparent trend. The estimated RER value for LCR chinook seems high intuitively. However, the fact that these populations have persisted over the years, albeit at low levels, despite very high ERs in the past suggests that these stocks are relatively productive and should be able to rebuild if mortality associated with harvest and other factors is reduced. Until further information is available, the current RER criteria represents the best available scientific data for evaluating whether harvest actions are consistent with survival and recovery. Fisheries, including ocean fisheries, will be managed so as not to exceed the current RER. The total expected AEQ ER for all fisheries in 2002 is 0.45 (0.347 ocean and 0.107 inriver, LeFleur 2002) and thus below the prescribed limit.

Although the discussion to this point related to tule chinook stocks has focused on the remaining stocks that are thought to be largely independent of hatchery influence and the overall ER that affects them, there is also a large component of hatchery-origin tules returning in 2002, most of which are part of the ESU although not listed. Over 133,000 tule chinook are expect to return to the area below Bonneville Dam with an additional 136,000 chinook destined for the Spring Creek National Fish Hatchery above Bonneville. Although the hatchery-origin stocks are not a substitute for natural-origin fish, they do provide opportunities to implement recovery efforts through supplementation. As a result, the fate of the tule component is not tied solely to that of the few remaining natural-origin stocks. The recovery planning process, which is just now getting under way, will identify those populations that are considered essential for recovery and a road map for rebuilding. In the meantime, NMFS will continue to evaluate and refine its



assessment of fishery related impacts to insure that the natural populations are available to contribute to future rebuilding efforts.

Three natural-origin bright stocks have also been identified. There is a relatively large and healthy stock on the North Fork Lewis River. The escapement goal for this system is 5,700. That goal has been met, and often exceeded by a substantial margin, every year since 1980 except for 1999. The escapement shortfall in 1999 is at least partly the result of severe flooding during the 1995 and 1996 brood years. The escapements of 8,700 in 2000 and 11,300 in 2001 were again well above goal.

The Sandy and East Fork Lewis stocks are smaller. Escapements to the Sandy have been relatively stable since counts began in 1984 and on the order of 1,000 fish per year. The average escapement since 1996 is about 700. Lower returns in 1999 and particularly 2000 may be related to flood events affecting the 1995 and 1996 broods. Escapement in 2001 was nearly 850. Escapements to the East Fork Lewis have been stable for at least the last 10 years and averaged about 130. Escapement in the East Fork in 2001 was over 200.

The expected harvest rate on LCR bright stocks in the proposed non-Indian fisheries is 7.5%. This compares to an average inriver harvest rate for 1980-1995 of 32% and an average over the last six years of 7%. The total exploitation rate including ocean fishery impacts has declined from 53% from 1980-1995 to 23% since 1996, representing a 57% reduction in overall harvest (Table 8).

The available CRI analysis provides additional perspective on whether the large harvest reductions for the tule and bright components of the LCR ESU are sufficient. The estimated lambda value for the ESU as a whole ranges from 0.98 to 0.88. However, this analysis is based on a combination of spring, tule, and bright stocks which have different life histories and are subject to very different harvest rates. Consideration of the available CRI metrics for some of the previously discussed tule and bright indicator stocks are easier to interpret.

The original CRI analysis did not report values for the Coweeman stock which provided the basis for the RER analysis. However, the estimated lambda for the East Fork Lewis tule stock is 0.99. (There is no range of values because the stock is presumably not affected by hatchery strays.) The probability of 90% decline in 100 years is 0.14. A more recent analysis of the Coweeman stock considered the CRI metrics assuming the survival improvements resulting from implementation of the 0.49 RER. (McClure, M., NMFS pers. com. w/ P. Dygert, NMFS April 5, 2002). The estimated lambda value was 1.13. The probability of 90% decline in 100 years was 0.0001. These statistics indicate that the stock is relatively stable and that the reduction in the overall ER should be sufficient to provide the necessary improvements in survival.

CRI statistics were developed for the bright stocks on the North Fork Lewis and Sandy rivers. Lambda values for the two stocks ranged from 0.969 to 0.991 and from 0.976 to 0.984, respectively (Table 4). The narrow range again reflects that the contribution, and thus uncertainty, related to hatchery-origin fish is relatively small. The reduction in the overall ER on

bright stocks in recent years is 55% and should be a sufficient improvement in survival sufficiently to provide for positive population growth so long as other factors do not continue to deteriorate.

The recovery planning process has also been initiated with the formal appointment of a Technical Recovery Team. In this case, the broader objective of the ESA, which requires survival and recovery of self-sustaining, naturally spawning populations, can best be achieved through focused recovery planning efforts that identify habitats that can be rehabilitated, coupled with supplementation and harvest management programs that provide the necessary protections that will allow for rebuilding. Until then harvest of tule and bright stocks needs to be sufficiently constrained to protect the remaining naturally spawning populations. The fact that these populations have been stable in recent years and that overall harvest mortality has declined by more than half suggests that the 2002 fall season fisheries do not pose a substantial risk to those populations nor limit the potential for longer-term recovery efforts.

Forthcoming results from the ongoing hatchery consultation, updated CRI analyses, and recovery planning efforts will help clarify critical questions related to population structure, recovery objectives, and the role of hatcheries in the recovery effort. Whether additional reductions are needed in harvest will depend on these efforts. But for now, based on the best available information, NMFS concludes that the impacts associated with the proposed 2002 fisheries are not likely to appreciably reduce the likelihood of survival and recovery of LCR chinook.

## **6.2 Steelhead**

During the course of consultation related to the 2002 fisheries, the state and tribal parties proposed to manage their fisheries subject to the same constraints for steelhead used over the last three years. The states of Oregon and Washington proposed to manage their fisheries using selective fishing techniques and limit the harvest rate on each of the effected ESUs to no more than 2%. The tribes proposed to manage their fishery subject to a 15% harvest rate on SR B-run steelhead with the expectation that the impacts will be substantially less for other stocks (<1% to < 5%, Table 10). In fact, the expected impacts to B-run steelhead associated with the proposed fisheries are somewhat less than the specified limits (1.7% vs. 2.0% and 14.9% vs. 15%) because the harvest constraints for SR fall chinook are likely to be more limiting.

As discussed in section 2.3.2 in some detail, B-run steelhead are a large and important component of the SR ESU that is at risk because of its current depressed status. B-run steelhead are also the component that is most vulnerable to the fisheries due to their later timing, larger size, and upstream location which requires them to pass through the full range of fall season fisheries. A-run steelhead, whether from the SR or other ESUs, benefit from the protections provide to B-run steelhead because they are subject to relatively lower harvest rates, again because of their smaller size, earlier timing, and, for the LCR and MCR ESUs, their downstream location. The winter run component of the LCR and MCR ESUs are also not subject to harvest in the fall season fisheries. B-run steelhead are therefore considered the most constraining of the steelhead stocks.

Having proposed the above described standard it is necessary in this opinion to again consider how it relates to the status of the species and environmental baseline, and whether it remains consistent with a no jeopardy conclusion for SR steelhead and other ESUs as well. NMFS here reviews the related considerations, and in the end concludes that reliance on the proposed 2% and 15% harvest rate limits, given the circumstances in 2002, is consistent with a no jeopardy finding. However, NMFS is not satisfied that a 17% harvest rate cap represents an appropriate long term plan that can be implemented regardless of the status of the species. Developing an alternative management plan that is more responsive to species abundance depends, in part, on resolving uncertainties related to escapement objectives for the listed steelhead ESUs. As discussed in section 2.3.2.1, there are at least three sets of escapement goals for SR steelhead that are significantly different and provide a very different perspective regarding the status of the ESU. If the returns of natural-origin SR B-run steelhead to LGD was 3,000 in 2001, our assessment of the status is very different depending on whether the escapement goal is 10,000 or 32,000 or something in between. An important part of the Management Agreement for 2001 was the commitment of the parties to review escapement goals that can then be used for future planning. Because of their importance to management, the escapement goals for SR steelhead were set as the first priority. Although that work is still not complete, TAC has made substantial progress in reviewing the available information and developing escapement recommendations for Snake River steelhead. This is an important step in the long term planning effort.

As an initial matter in considering whether expected impacts to B-run steelhead are acceptable it is important to acknowledge that SR B-run steelhead and thus the ESU is at risk of extinction as is indicated by their status as part of the listed ESU. This has come about as a result of the effects of a broad range of past and ongoing human activities and natural factors that comprise the environmental baseline which in aggregate have contributed to their decline and led to the current status of the species. The fisheries being considered here are not the last in a chain of sequential events that have put these species at risk. They are instead one action in a continuous cycle of actions that have contributed to the decline of the species. Clearly, if the aggregate effect of all mortalities are not significantly reduced and maintained at lower levels for the foreseeable future, the species will continue to decline to extinction.

Any harvest, or any action that involves take for that matter, involves some increase in the level of risk to the species. The tribes' views regarding the assumption of risk associated with their fisheries have substantial merit. The tribes have both a right and priority to conduct their fisheries within the limits of conservation constraints. Because of the Federal government's trust relationship with the tribes, NMFS is committed to consider the tribes' judgment and expertise when it comes to the conservation of trust resources. However, the opinion of the tribes and their immediate interest in fishing must be balanced against NMFS' responsibility pursuant to the ESA to ensure the survival and recovery of listed species and its trust responsibility which requires consideration of the long-term interests of the tribes as well. The tribes' long-term interests clearly require that the fishery resources be conserved even if it requires compromising short-term fishing objectives.

Steelhead impacts associated with fall season fisheries were managed from 1985 to 1997 pursuant to the guidelines contained in the now expired CRFMP. That Plan allowed for a tribal harvest rate on B-run steelhead during the fall season of 32%. The 32% cap was itself a reduced fishing level designed at the time to provide necessary protection to B-run steelhead. The average B-run harvest rate from 1985 to 1997 was 25.9% (Table 8). (In the above analysis for the chinook ESUs we considered the 1980-present time series to be consistent with the time frame adopted in the CRI analysis. Stock specific harvest rates for Snake River steelhead are available only since 1985.) Over the last four years when ESA constraints specific to B-run steelhead were first applied the harvest rate in the tribal fall season fishery has averaged 12.6%. The 15% harvest rate cap represents a 42% reduction from the long-term average harvest rate for the tribal fishery, and a 53% reduction from the CRFMP allowed harvest rate of 32%. The expected harvest rate on B-run steelhead in the tribes' 2001 fall season fisheries is 14.9% which is a 42% reduction from the long-term average.

The harvest rate on SR A-run steelhead averaged 14.3% from 1985 to 1997. The average harvest rate over the last four years has been 6.4% (Table 8). The expected harvest rate on SR A-run steelhead in this years' fall season fishery is 5.4% (Table 10).

In 2000, the tribes took additional management action designed to further reduce the incidental catch of steelhead in the fall season fishery. It was generally understood that steelhead catch rates could be reduced by using larger mesh gillnets. In 1997 and 1998 pilot studies were conducted that confirmed that nine inch mesh gillnets caught significantly fewer steelhead compared to the six, seven, and eight inch nets that were used most frequently during the fishery. Based on these results an agreement was reached in 2000 to purchase and distribute nine inch mesh gillnets in exchange for a commitment by each fishermen receiving the nets to use them whenever they participate in the fall fishery for the next five years. Although nets typically deteriorate with use and are ultimately phased out, some of the purchased nets remain in the fishery and thus help minimize incidental impacts to steelhead.

Non-Indian fishermen have also taken significant action to reduce steelhead catch rates. The most significant management actions in the non-Indian fisheries related to steelhead occurred several years ago. Managers for the non-Indian fisheries took a more regulatory approach designed to reduce the impact of their fisheries on wild steelhead in particular. Commercial harvest of steelhead by non-Indians has been prohibited since 1975; time, area, and gear restrictions limit handling and mortality of steelhead by the non-Indian gillnet fishery to < 1% of the run. In addition, all sport harvest is now restricted to fin-clipped hatchery steelhead only. Anglers have been required to release natural-origin steelhead in the CR since 1986. Of the fish that are caught and released, it is assumed that 10% will die from resulting injuries. Because of these conservation related actions, non-Indian fisheries are being managed under a 2% harvest rate cap. The expected harvest rate on SR A and B-run steelhead in the proposed 2002 non-Indian fisheries are 0.7% and 1.7%, respectively (Table 10).

At this point it is appropriate to consider additional information provided as a result of the FCRPS biological opinion and associated All-H paper. This is the most recent and comprehensive effort

intended to provide an overview of the status of listed species in the CRB, the combined effects of actions on those species, and their prospects for survival and recovery. The associated CRI analysis was an integral part of the FCRPS opinion in that it provided a consistent and objective analytical framework. The CRI analysis was used in conjunction with more qualitative considerations in the FCRPS opinion to develop the necessary conclusion related to jeopardy.

As described earlier, the CRI analysis provided an assessment of the status of ESUs and individual stocks that depended on a set of base years generally beginning in 1980. The analysis provided estimates of lambda which measured whether population growth rates were positive (greater than one) or negative (less than one). The FCRPS opinion recognized that, for most populations, actions had been taken in recent years that improved over the base conditions and that further improvements were expected as a result of implementing the Reasonable and Prudent Alternative (RPA). These lead to estimates of expected lambda values and associated risk statistics. As an example, it was necessary to make assumptions about what future harvest rates would be for steelhead. The analysis assumed that harvest rates for SR B-run steelhead would be limited to 17%. This represented an improvement over base period harvest rates.

The analysis accounted for harvest reductions and improvements in other sectors that had occurred or were expected to occur. The analysis then reassessed expected population growth rates and what additional improvements might be required to have a reasonable probability of meeting survival and recovery objectives. The analysis for steelhead generally suggested that there was still a need for substantial increases in survival. For example, the adjusted lambda estimate for B-run steelhead ranged from 0.80 to 0.90 even after harvest reductions and expected improvements from the hydro system were accounted for. Additional survival improvements needed to meet recovery objectives ranged from a factor of 1.92 to 4.33 - a two to fourfold increase in survival (Table 9.7-11, NMFS 2000a). Although B-run steelhead required the greatest additional improvement in survival, steelhead in general required additional survival improvements in order to meet survival and recovery objectives. The FCRPS opinion assumed that these additional improvements would be achieved through offsite mitigation and established a set of criteria and interim check points at three, five, and eight year intervals to assess progress towards recovery and the assumptions made in the opinion.

The analysis associated with the FCRPS opinion provides a rather pessimistic perspective regarding the status of steelhead populations. The analysis will be updated and continue to evolve, and will hopefully provided greater certainty about the survival improvements that are required and how best to achieve those improvements. In the meantime, there is additional information on more immediate circumstances that affect the status of the populations that were not accounted for in the CRI and FCRPS analysis. On the negative side there is a severe drought in the CRB in 2001. This is likely to have the greatest affect on the 2001 juvenile out-migrants and the subsequent adult returns which will occur primarily in 2003 and 2004. Because of the low flow conditions in 2001 an effort was made to trap and transport as many of the SR steelhead smolts as possible. Approximately 90% of the run was collected for transport. Returns in 2003 and 2004 will therefore depend more on survival rates of transport fish than survival of smolts that migrated inriver.

On the more positive side, it is apparent that ocean conditions have improved over the last two or three years, and that many of the stocks are responding favorably to those changing conditions. In the last three years there have been record returns of upriver spring chinook including the return of over 400,000 adults to Bonneville Dam in 2001 and over 300,000 in 2002, both records since counts began in 1938. The return of upriver summer steelhead in 2001 was more than twice the next highest return seen since at least 1984 with another strong return expected in 2002. The return of upriver fall chinook in 2001 was the highest observed since the peak years in the mid-80. An even larger return is expected in 2002. It is apparent the benefits of improved ocean conditions do not uniformly affect all stocks in all years. Coho and sockeye returns to the Columbia River were very strong in 2001, but are expected to be much lower in 2002.

We can not be sure that the improved conditions observed in recent years and being observed this year will persist. However, these conditions are more likely to persist if the recent observations portend a shift in the Pacific Decadal Oscillation. Improving ocean conditions may help offset some of the negative affects of the 2001 drought. Improving conditions are not a substitute for sustained improvements in the freshwater habitat conditions, but will certainly help by providing the time necessary to bring the improvements on line.

For now NMFS is satisfied that steelhead harvest rates have been substantially reduced in recent years, that further actions are being taken to reduce harvest, and that the expected impacts associated with this year's fisheries are sufficiently low to avoid jeopardizing the species. This conclusion is supported by recent upward trends and apparently improved ocean conditions. Although the discussion and analysis in this opinion has focused largely on SR B-run steelhead it is pertinent to recall that the expected harvest rates on other steelhead are substantially lower. The expected harvest rates on SR and UCR A-run stocks range from 5.4% to 6.5%. The expected harvest rates on the summer components of MCR and LCR steelhead are less than 5% and less than 2%, respectively (Table 10). However, the available CRI analysis and that contained in the FCRPS opinion underscore the uncertain status of all of the steelhead ESUs and their long-term prospects for recovery. Ongoing assessment of the status of the stocks will be critical.

NMFS, as a matter of policy, has not sought to eliminate harvest and as discussed in this opinion and elsewhere has accepted a certain measure of increased risk to the species to provide limited harvest opportunity, particularly to the tribes in recognition of their treaty rights and the Federal government's trust responsibility. Non-treaty fisheries are second in priority to tribal fisheries when it comes to fisheries that are limited by conservation constraints. But here too NMFS will seek, as a matter of policy, to provide some opportunity to access harvestable fish if the states and tribes can resolve critical questions related to allocation and with the proviso that the impacts are very limited and all possible measures are taken to minimize the incidental impacts to listed species. The implementation of steelhead mass marking and selective, non-retention fisheries by the northwest states serves as an example. Even so, the associated impacts must be accounted for and held to acceptable levels. NMFS will again rely on the anticipated updated CRI analysis and any other pertinent information or further analysis suggested by the All-H paper to refine the guidance related to impact limits and allocation priorities both between treaty and non-treaty fisheries and among the other mortality sectors.

NMFS believes that the harvest needs of the states and tribes during an interim period of recovery can best be achieved through a transition to selective fishery methods that can minimize the impacts to listed species and other weak stocks that require protection. NMFS' acceptance of the harvest rate standards for this year provides an opportunity to make necessary adjustments in the fisheries with a minimum of disruption. But ultimately fisheries will be managed, and catch will continue to be limited, based on the needs of the listed fish. NMFS also believes that fisheries should be managed based on the status of the fish they affect. The commitment in the 2001 Management Agreement, and ongoing work to reassess escapement goals, is a necessary step designed to help clarify the status of the affected populations. NMFS' objective is to use this information to develop a long-term abundance-based management plan that is more responsive to interannual changes in fish abundance. Once completed, the plan could provide the basis for a programmatic biological opinion that would cover the management of fall season fisheries for the foreseeable future. Based on these considerations, NMFS concludes that the impacts associated with the proposed 2002 fisheries are not likely to appreciably reduce the likelihood of survival and recovery of LCR, MCR, SR, or UCR steelhead ESUs.

### **6.3 Chum Salmon**

Chum salmon are not caught in tribal fisheries above Bonneville dam. Chum are caught occasionally in non-Indian fisheries below Bonneville. However, catch rates are quite low. There are no fisheries targeted at hatchery or natural-origin chum. There are also no chum hatchery production programs in the Columbia Basin except for those designed to supplement natural production. The later fall return timing of chum is such that they are vulnerable to relatively little potential harvest in fisheries that target primarily chinook and coho. Chum rarely take the kinds of sport gear that is used to target other species.

Harvest rates are difficult to estimate since we do not have good estimates of total run size. Spawning surveys focus on index areas and so provide estimates for only a portion of the run. However, the incidental catch of chum amounts to a few 10's of fish per year. The harvest rate in proposed state fisheries in the lower river is estimated to be 1.6% and is almost certainly less than 5%. The lambda estimate from the available CRI analysis is 1.035 indicating that the population levels are increasing and that there is little short or long-term risk of extinction or significant decline. Based on these considerations, NMFS concludes that the impacts associated with the proposed 2002 fisheries are not likely to appreciably reduce the likelihood of survival and recovery of CR chum salmon.

### **7.0 CONCLUSION**

After reviewing the current status of the listed ESUs considered in this opinion, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, it is NMFS' biological opinion that the proposed 2002 fall season fisheries are not likely to jeopardize the continued existence of the SR or LCR chinook salmon, LCR, MCR, SR, or UCR steelhead, or CR chum ESUs.

The designated critical habitat for Snake River fall chinook and the essential habitat features for the other ESU considered in the opinion are not affected by the proposed fisheries. The activities considered in this consultation will therefore not result in the destruction or adverse modification of any of the essential features of designated critical habitat.

## **8.0 INCIDENTAL TAKE STATEMENT**

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. “Harass” is defined as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. “Incidental take” is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

The measures described below are non-discretionary; they must be undertaken by the action agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The action agencies have a continuing duty to regulate the activity covered in this incidental take statement. If the action agencies (1) fail to assume and implement the terms and conditions or (2) fail to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the agencies must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement. [50 CFR §402.14(I)(3)]

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures.

### **8.1 Amount or Extent of Incidental Take Anticipated**

The amount of anticipated take is expressed in terms of harvest rates since it is the harvest rates rather than estimates of individual mortalities that limit the extent of allowable take.



### **8.1.1 Chinook Salmon**

The expected harvest rates on SR fall chinook in proposed treaty Indian and non-Indian fisheries are 8.25% and 23.04% although the distribution of harvest impacts may vary.

The tribal fisheries are not expected to affect the LCR chinook ESU. There will be no effect to the spring component of the LCR ESU in the proposed non-Indian fisheries. The expected harvest rates in the non-Indian fisheries on the tule and bright components are 16.4% and 7.5%, respectively. However, harvest rates to the LCR stock components may vary inseason. The proposed fall season fisheries are subject to combine ocean and inriver RER for LCR tules of 0.49. The non-Indian fisheries will be constrained primarily by the harvest rate limits for SR fall chinook and steelhead.

### **8.1.2 Steelhead**

The combined harvest rate of all proposed treaty Indian fisheries on LCR and MCR (hatchery and natural-origin) steelhead are 1.0% and 3.9%, respectively. The expected harvest rates on UCR natural and hatchery-origin steelhead are 5.0% and 6.7%, respectively. The expected harvest rates on SR A and B-run steelhead are 4.7% and 14.9%, respectively. These harvest rates may increase or decrease in season, but are limited by the treaty Indian harvest rate on SR B-run steelhead that may not exceed 15%.

The catch of natural-origin steelhead from the LCR, MCR, UCR, and SR ESUs in the proposed non-Indian fisheries is subject to a harvest rate limit of  $\leq 2\%$  and for hatchery-origin UCR steelhead a harvest rate of  $\leq 15\%$ . The actual harvest rates are expected to be lower than the prescribed limits (Table 10).

### **8.1.3 Chum Salmon**

The expected take of LCR chum in the proposed treaty Indian fisheries is zero. The harvest rate proposed on LCR chum for the non-Indian fishery is  $\leq 5\%$  with an expected harvest rate of 1.6%.

## **8.2 Effect of the Take**

In this biological opinion, NMFS has determined that the level of take anticipated is not likely to jeopardize the continued existence of listed salmonid species or result in the destruction or adverse modification of designated critical habitat.

## **8.3 Reasonable and Prudent Measures**

NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize the impacts from fisheries considered in this opinion to listed steelhead and salmon ESUs.

1. The Washington Department of Fish and Wildlife (WDFW) shall monitor the passage of salmonids at CR dams. The TAC shall provide necessary inseason estimates of run size.
2. WDFW and Oregon Department of Fish and Wildlife (ODFW) shall monitor the catch for recreational and commercial fisheries in Zones 1-6.
3. WDFW and ODFW shall sample the recreational and commercial fisheries in Zones 1-6 for stock composition.
4. The Columbia River Inter-tribal Fish Commission (CRITFC) and its member tribes shall monitor the catch in all tribal ceremonial and subsistence (C&S) fisheries and platform fisheries, and in commercial fisheries in cooperation with the monitoring efforts of the states.
5. CRITFC and its member tribes shall sample the Zone 6 C&S fishery for stock composition.
6. The TAC shall account for the catch of each fishery as it occurs through the season and report to NMFS the results of these monitoring activities and, in particular, any anticipated or actual increases in the incidental harvest rates of listed species from those expected preseason.

#### **8.4 Terms and Conditions**

In order to be exempt from the prohibitions of section 9 of the ESA, the action agencies must ensure that the tribes and states comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. WDFW shall obtain daily counts of all salmonids passing Bonneville, The Dalles, John Day, and McNary dams. The TAC shall use dam counts and other available information to develop inseason updates to run size estimates for fall chinook and steelhead.
2. Monitoring of catch in the recreational and Zone 1-6 commercial fisheries by WDFW and ODFW shall be sufficient to provide statistically valid estimates of the salmon and steelhead catch. Sampling of the commercial catch shall entail daily contact with buyers regarding the catch of the previous day. The recreational fishery shall be sampled using effort surveys and suitable measures of catch rate.
3. WDFW and ODFW shall monitor the stock composition of the recreational fisheries and Zone 1-6 commercial fisheries using a target sampling rate of 20%.
4. Monitoring of catch in the Zone 6 fisheries by CRITFC and its member tribes shall be sufficient to provide statistically valid estimates of the catch of salmon and steelhead. The

catch monitoring program shall be stratified to include platform, hook-and-line, and gillnet fishery components.

5. CRITFC and its member tribes shall monitor the stock composition of the Zone 6 C&S fisheries using a target sampling rate of 20%.
6. The TAC shall account for the catch of each fishery as it occurs through the season. If it becomes apparent inseason that any of the established harvest rate limits may be exceeded due to catch or revisions in the run-size projection, then the states and tribes shall take additional management measures to reduce the anticipated catch as needed to conform to the limits.

## **9.0 CONSERVATION RECOMMENDATIONS**

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS believes the following conservation recommendations should be implemented:

1. The current methods available for stock separation of natural-origin steelhead are limited to information related to fish length or passage timing. The ability to assess harvest mortality to different components of the composite steelhead return is critical. The U.S. v Oregon parties have rejected the date-based method previously used to assess steelhead run composition and composition of the harvest in favor of a revised length-based method. The current method, as developed and applied by the TAC uses a fork length cut-off of 77.5 cm to approximate a division between smaller, “A-run-like” fish and larger steelhead assumed to represent B-run fish. This approximation is determined to be sufficiently representative of the actual A-run vs. B-run separation to be appropriate for inseason management.

However, the revised length method must be considered interim. The revised length method does not fully portray detailed impacts to A-run or B-run fish, nor does it allow further segregation of impacts among listed ESUs which are composed of A-run fish or any further subdivision of those ESUs.

Efforts have been undertaken in recent years to collect biological samples at adult passage facilities and in fisheries to develop information databases necessary to evaluate and implement other, more specific steelhead stock composition techniques. It is generally anticipated, pending additional refinement and analysis of baseline data, that Genetic Stock Identification (GSI) methodology, or methods based on reading of scales, will provide the level of detail necessary to sufficiently assess impacts to wild steelhead in a timely manner and at the appropriate level of stock resolution. Therefore, the fishery co-managers should complete their assessment of work done to date and provide recommendations regarding its use and implementation in the future.

2. Restrictions on harvest for protection of natural-origin steelhead will reduce the tribes' ability to access harvestable fall chinook and hatchery steelhead using traditional fishing methods. The U.S. v Oregon parties, including the federal government, the tribes, and the states, should work to develop alternative fishing methods that reduce impacts to wild steelhead while more selectively targeting harvestable stocks. The alternative is to limit mixed stock fisheries according to the conservation needs of the weak stocks and thereby forego the catch of otherwise harvestable fish. Methods to be evaluated should include, but not necessarily be limited to:

- a. Modifications to net types used in the mainstem Columbia River, with the intent to either avoid the encounter of certain species through maximum or minimum mesh size regulations, or to increase the ability to release nontarget fish unharmed through use of tangle nets, tooth nets, or other similar gear. A multi-year fishery evaluation by the YIN suggests that the use of minimum mesh size regulation may be quite effective selectively catching chinook salmon while reducing impacts to steelhead in mainstem fisheries. Available information suggests that the use of "weed-line" gear which incorporates a panel of large mesh at the top of a gillnet is effective in avoiding steelhead which migrate close to the surface. Recent studies on the use of tooth nets for selective commercial harvest indicate catch-and-release survival rates of 98% and 100% for chinook salmon and steelhead, respectively. These and other similar approaches should be evaluated. Funding needs for research and, if warranted, implementation, and appropriate funding sources, should be identified.
- b. Catch-and-release of unmarked steelhead should be implemented in tribal dipnet and hoopnet fisheries. In the 1998 mainstem CR fall season fishery, an estimated 42 wild-A and 380 wild-B steelhead were taken in the treaty Indian platform ceremonial and subsistence fishery. Had the platform fishery been implemented with a regulation requiring live release of unmarked steelhead, a savings of approximately 2½ percentage points in the overall wild-B steelhead harvest rate would have resulted. Additional opportunities for dipnet and hoopnet fisheries in tributary areas, particularly in areas with runs dominated by hatchery returns, should be sought or developed, with the additional benefit that such sites are likely to be much closer to or actually on tribal lands.
- c. The potential use of fish traps and fish wheels or other live capture methods in the mainstem Columbia River, in off-mainstem areas, and in tributaries should be carefully considered. In some cases, both technical and regulatory constraints to the use of such gear exist. In particular, the potential catch of traps and fish wheels is highly site-specific, and appropriate locations in the mainstem may not exist. However, the high selectivity of such gear, including the extremely low mortality rates apparently associated with catch-and-release of nontarget species indicate that such gear types merit further evaluation.

3. The mortality risks associated with the handling and live release of salmonids in fisheries are exacerbated by stresses associated with warm water conditions. At water temperatures above approximately 70° F, biological functions are impaired and fish die as a direct result of high

temperatures (Environmental Protection Agency (EPA) 1971). Even at somewhat lower temperatures, while salmon may not suffer significant mortalities as a direct result of handling, metabolic stresses increase the susceptibility of individuals to other adverse effects, and additional stresses from other sources which cumulatively increase the likelihood of mortality (Wilkie *et al.* 1996; Wydoski *et al.* 1976; Bell 1990). The probability of hooking mortality of adult summer steelhead angled in the Mad and North Fork Trinity Rivers increased markedly (from less than 5% to nearly 45%) when water temperatures increased from 18°C to 25°C (G. Taylor, ODFW, pers. comm., to H. Pollard, NMFS, August 17, 1998). Mortality of rainbow trout played to exhaustion has been shown to significantly increase with increases in water temperature (Dotson 1982).

An additional concern associated with high mainstem water temperatures involves fisheries in cold water refugia, such as the mouths of Herman Creek and the Klickitat River and Drano Lake. Current recreational fishery regulations based on average estimated encounter rates may be substantially in error when actual encounter rates in fisheries with significant effort are much higher. When water temperatures in larger river main stems increase, upstream-migrating adult salmonids “dip in” to the mouth of tributaries, where temperatures are lower. The fish concentrate in these areas and hold until mainstem temperatures begin to decrease. As a result of the assemblages of fish, fisheries also tend to intensify in these tributary areas, with several potential adverse effects: the fisheries are more concentrated; the hooking rate per fish may increase; and the fish are already likely to be debilitated from warm water effects. The resultant damage to migrating stocks of salmonids is potentially high, and may require significant reduction of fishing in these refugia areas during adult migration to protect spawning escapements upstream.

The extent to which warm water actually increases mortality rates in CR fisheries is unclear, but significant benefits to salmonid rebuilding and recovery may be available through additional fishery management actions designed to address high water temperatures. For example, in response to similar concerns, the State of Maine’s Conservation Plan recommends that catch-and-release fisheries on Atlantic salmon be closed during periods of water temperatures in excess of 68°F (20°C) (The Maine Atlantic Salmon Task Force 1997). The U.S. v. Oregon federal, tribal, and state fishery co-managers should explore and develop actions addressing the following concerns.

- a. The federal, tribal, and state fishery agencies should compile and evaluate existing data on temperature effects on salmonid survival, and identify and implement additional research needed to identify whether fishery constraints during warm water periods are warranted, and, if so, at what temperature such constraints should be applied.
- b. The states of Oregon, Washington, and Idaho should explore criteria for application and the potential for recreational fishery regulations restricting fisheries during periods of excessively high water temperatures. The tribes should explore similar criteria for tribal gillnet restrictions during periods of warm water, to decrease mortalities accruing to non-target steelhead encountering but escaping from gillnets, particularly large-mesh nets used

to reduce impacts to steelhead.

c. The tribes and states should consider closing all cold water refugia to fishing activities during periods of excessively high mainstem water temperatures.

d. The parties should develop information outreach programs to instruct fishers on the implications of fishing during warm water conditions. This education should address the need to reduce fight time and other undue sources of fishing stress by landing fish quicker, using gear of greater strength, and by leaving in the water any fish intended to be released.

## **10.0 REINITIATION OF CONSULTATION**

This concludes formal consultation on the 2002 fall season fisheries in the CRB. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

NMFS finds the management constraints contained in this opinion necessary for the conservation of the affected listed species. In arriving at these management constraints, NMFS has been mindful of affected treaty rights and its Federal trust obligations. NMFS will reconsider the management constraints in this opinion that affect treaty rights in the event new information indicates such reconsideration is warranted.

## **11.0 MAGNUSON-STEVENSON ACT ESSENTIAL FISH HABITAT CONSULTATION**

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for those species regulated under a Federal fisheries management plan. Pursuant to the MSA:

- Federal agencies must consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2));
- NMFS must provide conservation recommendations for any Federal or State action that would adversely affect EFH (§305(b)(4)(A));
- Federal agencies must provide a detailed response in writing to NMFS within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the

impact of the activity on EFH. In the case of a response that is inconsistent with NMFS EFH conservation recommendations, the Federal agency must explain its reasons for not following the recommendations (§305(b)(4)(B)).

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting this definition of EFH: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR 600.10). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

EFH consultation with NMFS is required regarding any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH.

### **11.1 Identification of Essential Fish Habitat**

Pursuant to the MSA, the Pacific Fisheries Management Council (PFMC) has designated EFH for three species of federally-managed Pacific salmon: chinook (*Oncorhynchus tshawytscha*); coho (*O. kisutch*); and Puget Sound pink salmon (*O. gorbuscha*) (PFMC 1999). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (*i.e.*, natural waterfalls in existence for several hundred years). Detailed descriptions and identifications of EFH for salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of potential adverse effects to these species' EFH from the proposed action is based, in part, on this information.

### **11.2 Proposed Action and Action Area**

For this EFH consultation, the proposed actions and action area are as described in detail above. The action is the issuance of an incidental take statement pursuant to section 7 of the ESA. The proposed action area includes the Columbia River from its mouth upstream to the Wanapum

Dam, including its tributaries (with the exception of the Willamette River). The action area includes habitats that have been designated as EFH for various life-history stages of chinook and coho salmon. A more detailed description and identification of EFH for salmon is found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of the impacts on these species' EFH from the above proposed action is based on this information.

### **11.3 Effects of the Proposed Action**

Based on information submitted by TAC, as well as NMFS' analysis in the ESA consultation above (see particularly section 4.1), NMFS believes that the effects of this action on EFH are likely to be within the range of effects considered in the ESA portion of this consultation.

### **11.4 Conclusion**

Using the best scientific information available and based on its ESA consultation above, as well as the foregoing EFH sections, NMFS has determined that the proposed actions are not likely to adversely affect Pacific salmon EFH.

### **11.5 EFH Conservation Recommendation**

Pursuant to Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. The Reasonable and Prudent Measures and the Terms and Conditions outlined above are applicable to designated salmon EFH. Therefore, NMFS recommends that those same Reasonable and Prudent Measures, and the Terms and Conditions be adopted as the EFH Conservation Recommendation for this consultation.

### **11.6 Statutory Response Requirement**

Pursuant to the MSA (§305(b)(4)(B)) and 50 CFR 600.920(j), Federal agencies are required to provide a detailed written response to NMFS' EFH conservation recommendations within 30 days of receipt of these recommendations. The response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on EFH. In the case of a response that is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

### **11.7 Consultation Renewal**

The action agencies must reinitiate EFH consultation if plans for these actions are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for the EFH conservation recommendations (50 CFR Section 600.920(k)).



## 12.0 REFERENCES

- Allen, R.L., and T.K. Meekin. 1973. An evaluation of the Priest Rapids chinook salmon spawning channel, 1963-1971. Wash. Dept. Fisheries, Technical Report 11:1-52 p.
- Barnhart, R.A. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--steelhead. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.60). 21p.
- Behnke, R.J. 1992. Native trout of western North America. American Fisheries Soc. Monog. 6. Am. Fish. Soc., Bethesda, MD. 275p.
- Becker, D.C. 1970. Temperature, timing, and seaward migration of juvenile chinook salmon from the central Columbia River. AEC Research and Development Report, Battelle Northwest Laboratories. Richland, WA. 21 p.
- Bell, M.C. 1990. Fisheries handbook of engineering requirements and biological criteria. 1990. Fish Passage Development and Evaluation Program, U.S. Army Corps of Engineers.
- Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers, Office of the Chief of Engineers, Fish Passage Development and Evaluation Program, North Pacific Division, Portland, OR.
- Biological Requirements Work Group (BRWG). 1994. Analytical methods for determining requirements of listed Snake River salmon relative to survival and recovery. Progress Report, October 13, 1994. 129 p w/ Appendices.
- Burgner, R.L., J.T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish Comm. Bull. 51. 92p. In Busby *et al.* (1996).
- Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-27. 261p.
- Chilcote, M.W. 1998. Conservation status of steelhead in Oregon. Oregon Dept. of Fish and Wildlife, Portland, 108 p.
- Collis, K., S. Adamany, D. D. Roby, D. P. Craig, and D. E. Lyons. 1999. Avian predation on juvenile salmonids in the lower Columbia River. Report to Bonneville Power Administration and U.S. Army Corps of Engineers. Columbia River Inter-Tribal Fish Commission, Portland, Oregon, and Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis. October.

- Columbia Basin Bird Research. 2000. Avian predation project update, draft season summary. <http://www.columbiabirdresearch.org> (accessed November 11).
- Columbia Basin Fish and Wildlife Authority. 1990.
- Cramer, S. P., J. Norris, P. Mundy, G. Grette, K. O'Neal, J. Hogle, C. Steward, and P. Bahls. 1999. Status of chinook salmon and their habitat in Puget Sound, volume 2. S. P. Cramer and Associates, Inc., Final Report, Gresham, Oregon.
- CRITFC. 1995. Wy-Kan-Ush-Me-Wa-Kish-Wit Spirit of the Salmon, The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes. Portland, Oregon. 2 volumes. Available Online at: <http://www.critfc.org/text/work.html>
- Darm, D. and R. Lent. 2001. Letter to J. Lone, Chairman PPMC. March 2, 2001. p. 9.
- Dotson, T. 1982. Mortalities in trout caused by gear type and angler-induced stress. N. Amer. J. Fish. Manage. 2:60-65.
- Doppelt, B., M. Scurlock, C. Frissell, and J. Karr. 1993. Entering the watershed: a new approach to save America's river ecosystems. Island Press, Washington D.C.
- Environmental Protection Agency (EPA). 1971. Columbia River Thermal Effects Study, Vol. I: Biological effects studies. EPA, in cooperation with the Atomic Energy Commission and the National Marine Fisheries Service. January 1971.
- Everest, F.H. 1973. Ecology and management of summer steelhead in the Rogue River. Oregon State Game Comm. Fish. Res. Rep. No. 7, Corvallis. 48p.
- Federal Caucus. 2000. Conservation of Columbia River Fish: Final Basinwide Salmon Recovery strategy. December. <http://www.samonrecovery.gov>
- Fish Passage Center (FPC). 2001. Adult salmon passage counts. Fish Passage Center internet website: [http://www.fpc.org/adult\\_history/adultsites.html](http://www.fpc.org/adult_history/adultsites.html) (accessed July 20, 2001).
- Flagg, T. A., F. W. Waknitz, D. J. Maynard, G. B. Milner, and C.V.W. Mahnken. 1995. The effect of hatcheries on native coho salmon populations in the lower Columbia River. *In* Uses and effects of cultured fishes in aquatic systems. Transactions of the American Fisheries Society 15:366-375.
- Frissell, C. A. 1993. A new strategy for watershed restoration and recovery of Pacific salmon in the Pacific Northwest. Prepared for the Pacific Rivers Council, Eugene, Oregon.
- Ford, M., et al. 2001. Upper Columbia River steelhead and spring chinook salmon population

- structure and biological requirements. Final Report, March 2001. prepared by UCR Steelhead and Spring Chinook Salmon Biological Requirements Committee. p. 64.
- Giger, R.D. 1973. Streamflow requirements of salmonids. Oregon Wildl. Commission. Job Final Report, Project AFS-62-1, Portland. *In* Bjornn and Reiser (1991).
- Gilbert, C.H. 1912. Age at maturity of Pacific coast salmon of the genus *Oncorhynchus*. Bull. U.S. Fish Comm. 32:57-70.
- Greer, J.W. and J.P. Koenings. 2000a. Letter to W. Stelle, NMFS. May 1, 2000. 2 p. w/attached section 7/10 assessment/permit application.
- Greer, J. and J. Koenings 2000b. Letter to W. Stelle, NMFS. Re: Amendment to permit application. July 20, 2000. 1p..
- Hartt, A.C. and M.B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and steelhead trout. International North Pacific Fisheries Commission Bulletin 46:1-105. *In* Nickelson et al. (1992a).
- Healey, M.C. 1983. Coastwide distribution and ocean migration patterns of stream- and ocean-type chinook salmon, *Oncorhynchus tshawytscha*. Can. Field-Nat. 97:427-433.
- Healey, M.C. 1986. Optimum size and age at maturity in Pacific salmon and effects of size-selective fisheries. Can. Spec. Publ. Fish. Aquat. Sci. 89:39-52.
- Healey, M.C. 1991. The life history of chinook salmon (*Oncorhynchus tshawytscha*). *In* C. Groot and L. Margolis (eds.), Life history of Pacific Salmon. Univ. of British Columbia Press. Vancouver, B.C.
- Henjum, M. G., J. R. Karr, D. L. Bottom, D. A. Perry, J. C. Bednarz, S. G. Wright, S. A. Beckwitt, and E. Beckwitt. 1994. Interim Protection for late-successional forests, fisheries, and watersheds: national east of the Cascade Crest, Oregon and Washington. The Wildlife Society, Bethesda, Maryland.
- Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Knedra, and D. Orrmann. 1985. Stock assessment of Columbia River anadromous salmonids. Vol. I. U.S. Dept. of Energy, Bonneville Power Administration. Project No. 83-335. 558p.
- Hymer, J. 1993. Estimating the natural spawning chum population in the Grays River Basin, 1944-1991. Columbia River Lab. Prog. Rep. 93-17, 17 p. Wash. Dep. Fish. Wildl., Columbia River Lab., P.O. Box 999, Battle Ground, WA 98604.
- Hymer, J. 1994. Estimating chum salmon population in Hardy Creek, 1957-1993. Columbia River Lab. Prog. Rep. 94-11, 15 p. Wash. Dep. Fish. Wildl., Columbia River Lab., P.O. Box

- 999, Battle Ground, WA 98604.
- IDFG. 1992. Anadromous Fish Management Plan. 1992-1996. 217 p.
- Independent Science Group (ISG). 1996. Return to the river: Restoration of salmonid fishes in the Columbia River ecosystem. Northwest Power Planning Council, Portland, Oregon. Publication No. 96-6. 584 pp.
- Jackson, P.L. 1993. Climate. In P.L. Jackson and A.J. Kimerling (editors), Atlas of the Pacific Northwest, p. 48-57. Oregon State Univ. Press, Corvallis.
- Jamison, B. 2000. Biological Assessment of the incidental impacts on salmonid species listed under the Endangered species Act in the 2000 treaty Indian fall season fisheries in the Columbia River. 79p.
- Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Ore. Dep. Fish Wildl. Rep., 217p. + app.
- LeFleur, C. 2001. Memo to the U.S. v. Oregon Technical Advisory Committee. WDFW Updated Fall Biological Assessment Tables.
- LeFleur, C. 2002. Memorandum re: U.S. v. Oregon, Fall Season 2002 Biological Assessment and Request for Section 7 Consultation, to P. Dygert, NMFS. July 2, 2002. p.1 w/ enclosure.
- Lohn, B. 2002. Letter to F. L. Cassidy, Jr. Chairman, Northwest Power Planning Council. April 4, 2002. 2 p. w/ enclosure.
- Lohn, D.R. and R. McInnis. 2002. Letter to H. Radtke, Chairman, Pacific Fisheries Management Council. March 8, 2002. 8 p. w/enclosure.
- Lower Columbia River Estuary Program. 1999. Comprehensive Conservation and Management Plan. Volume 1: June 1999. Lower Columbia River Estuary Program, Portland, Oregon.
- Marmorek, D.R., C.N. Peters, and I. Parnell (editors). 1998. Plan for Analyzing and Testing Hypotheses (PATH) Final Report for Fiscal Year 1998. December 16, 1998. 263p.
- Marshall, A.R., C. Smith, R. Brix, W. Dammers, J. Hymer, and L. LaVoy. 1995. Genetic diversity units and major ancestral lineages for chinook salmon in Washington. In C. Busack and J. B. Shaklee (eds.), Genetic diversity units and major ancestral lineages of salmonid fishes in Washington, p. 111-173. Wash. Dep. Fish Wildl. Tech. Rep. RAD 95-02. (Available from Washington Department of Fish and Wildlife, 600 Capital Way N., Olympia WA 98501-1091.)

- Mealy, S.P.. 1997. Letter regarding the State of Idaho's comments on the proposed listing of Snake River steelhead for protection under the Federal Endangered Species Act. February 11, 1997. 1 p. + enclosure
- McElhany, P., M. Ruckelsoaus, M.J. Ford, T. Wainwright, and E. Bjorkstedt. Draft - Viable salmonid populations and the recovery of evolutionarily significant units. NMFS. December 13, 1999. 161 p.
- McElhany, P., M. Ruckelshaus, M.J. Ford, T. Wainwright, and E. Bjorkstedt. 2000. Viable Salmonid Populations and the recovery of Evolutionarily Significant Units. Draft report dated January 6, 2000. National Marine Fisheries Service, Northwest Fisheries Science Center, Cumulative Risk Initiative, Seattle, Washington. 125 p.
- McClure, B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000a. Revised Appendix B of standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. September 2000.
- McClure, M. M., B. L. Sanderson, E. E. Holmes, and C. E. Jordan. 2000b. A large-scale, multi-species risk assessment: anadromous salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. Submitted to Ecological Applications.
- McPhail, J.D., and C.C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Bull. Fish. Res. Board Canada 173: 381.
- Meehan, W.R. and T.C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47-82 in W.R. Meehan (ed.), Influences of forest and rangeland management on salmonid fishes and their habitats. Am. Fish. Soc. Spec. Pub. 19. Bethesda, MD. 751p.
- Mealy, S. P. 1997. Letter regarding the State of Idaho's comments on the proposed listing of Snake River steelhead for protection under the federal Endangered Species Act. February 11, 1997. 1 p. w/ enclosure.
- Miller, R.J., and E.L. Brannon. 1982. The origin and development of life-history patterns in Pacific salmon. In E.L. Brannon and E.O. Salo (eds.), Proceedings of the Salmon and Trout Migratory Behavior Symposium. Univ. Washington Press; Seattle, Washington.
- Mullan, J.W., A. Rockhold, and C.R. Chrisman. 1992a. Life histories and precocity of chinook salmon in the mid-Columbia River. Prog. Fish-Cult. 54:25-28.
- Mullan, J.W., K.R. Williams, G. Rhodus, T.W. Hillman, and J.D. McIntyre. 1992b. Production and habitat of salmonids in mid-Columbia River tributary streams. U.S. Fish and Wildlife Service Monograph I. 489 p.

- Myers and 10 co-authors. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443p.
- Myers, J., C. Busack, D. Rawding, A. Marshall. 2002. Identifying historical populations of chinook and chum salmon and steelhead within the Lower Columbia River and Upper Willamette River Evolutionarily significant Units. Co-manager Review Draft. May 10, 2002. 70 p. w/appendices.
- National Marine Fisheries Service (NMFS). 1991. Factors for decline. A supplement to the notice of determination for Snake River fall chinook salmon under the Endangered Species Act. June 1991. 55 p.
- NMFS. 1995. Proposed recovery plan for Snake River salmon. March 1995.
- NMFS. 1996a. Biological opinion re Impacts on listed Snake River salmon by fisheries conducted pursuant to the 1996-1998 management agreement for upper Columbia River fall chinook. July 31, 1998. 20 p.
- NMFS. 1996b. Endangered Species Act - Section 7 Consultation. Impacts on listed Snake River salmon by fisheries conducted pursuant to the 1996-1998 Management Agreement for Upper Columbia river fall chinook. July 31, 1996. 20p.
- NMFS. 1998. Endangered Species Act - Section 7 Consultation. Reinitiation of consultation to consider impacts to listed steelhead resulting from 1998 fall season fisheries conducted under the Columbia River Fish Management Plan and 1996-1998 Management Agreement. September 10, 1998. 20 p. w/ attachment.
- NMFS. 1999a. Endangered Species Act - Section 7 Consultation. Biological opinion on artificial propagation in the Columbia River Basin. March 29, 1999.
- NMFS. 1999b. Endangered Species Act - Section 7 Consultation. Biological opinion and Incidental Take Statement. 1999 treaty Indian and non-Indian fall season fisheries in the Columbia River basin. July 30, 1999. 67p.
- NMFS. 1999c. Endangered Species Act - Reinitiated Section 7 Consultation - Approval of the Pacific Salmon Treaty by the U.S. Department of State and Management of the Southeast Alaska Salmon Fisheries Subject to the Pacific Salmon Treaty. NMFS, Protected Resources Division. November 9, 1999. 90 p. + figures.
- NMFS. 2000a. Endangered Species Act section 7 Biological Opinion on the reinitiation of consultation on operation of the federal Columbia River Power System, including juvenile fish transportation programs, and 19 Bureau of Reclamations projects in the Columbia Basin. December 2000.

- NMFS. 2000b. Biological opinion. Impacts of treaty Indian and non-Indian year 2000 winter, spring, and summer season fisheries in the Columbia River basin, on salmon and steelhead listed under the Endangered Species Act.
- NMFS. 2000c. Endangered Species Act - Reinitiated Section 7 Consultation - Effects of Pacific coast ocean and Puget Sound salmon fisheries during the 2000-2001 annual regulatory cycle. NMFS, Protected Resources Division. April 28, 2000. 99 p.
- NMFS. 2000d. RAP: A risk assessment procedure for evaluating harvest mortality on Pacific salmonids. NMFS, Sustainable Fisheries Division and NWFSC, Resource Utilization and Technology Division. May 30, 2000 draft. 33 p.
- NMFS. 2001a. Joint State Tribal Resource Management Plan Provided by the Washington Department of Fish and Wildlife and the Puget Sound Tribes For Salmon Fisheries Affecting Puget Sound Chinook Salmon Under Limit 6 of the 4(d) Rule - Determination Memo. Memo from B. Robinson to D. Darm. NMFS NW Region. April 26, 2001.
- NMFS. 2001b. Biological Opinion. Impacts of the Interim Management Agreement for upriver spring chinook, summer chinook, and sockeye salmon and steelhead listed under the Endangered Species Act. March 21, 2001. 97p. Available at: <http://www.nwr.noaa.gov/1sustfsh/biops.htm>
- NMFS. 2001c. Biological Opinion. Impacts of Treaty Indian and Non-Indian fall season fisheries in the Columbia River Basin in year 2001 on salmon and steelhead listed under the Endangered Species Act. August 10, 2001. 90p.
- Nicholas, J.W. and D.G. Hankin. 1988. Chinook salmon populations in Oregon coastal river basin: Description of life histories and assessment of recent trends in run strengths. Oregon Dep. Fish Wildl. Info. Rep. 88-1. 359p. (Available from Oregon Dept. Fish Wildl., P.O. Box 59, Portland, OR 97207.). In August 9, 1996, 61 FR 41545.
- Nickelson, T.E., J.W. Nicholas, A.M. McGie, R.B. Lindsay, D.L. Bottom, R.J. Kaiser, and S.E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Unpublished manuscript. Oregon Dept. Fish Wildl., Research and Development Section, Corvallis, and Ocean Salmon Management, Newport. 83p.
- Norman, G. and B. Tweit. 2001. ESA section 7/10 application for the incidental take of listed species in Washington and Oregon mainstem fisheries of the Columbia River August through December, 2001.
- Northwest Fisheries Science Center (NWFSC). 2000. A standardized quantitative analysis of risks faced by salmonids in the Columbia River Basin. April 7, 2000. 127p w/appendices. ([Http://www.nwfsc.noaa.gov/cr/](http://www.nwfsc.noaa.gov/cr/)).

- Northwest Power Planning council. 1992. Information on water quality and quantity contained in the Salmon and Steelhead Subbasin Plans (above Bonneville Dam) (Document 93-8).
- Oregon Water Resources Department. 1993. Memorandum from T. Kline and B. Fujii, Oregon water Resources Department, to David Moscovitz, et al., regarding weak stocks and water supply conflicts (September 17, 1993).
- Overberg, K. 2001. Biological Assessment of the incidental impacts on salmonid species listed under the Endangered species Act in the 2001 treaty Indian fall season fisheries in the Columbia River. 97p w/tables.
- PFMC (Pacific Fisheries Management Council). 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon. Pacific Fishery Management Council, Portland, Oregon.
- PFMC. 2002a. Preseason Report I Stock Abundance for 2002 Ocean Salmon Fisheries. February 2002.
- PFMC. 2002b. Preseason Report III Analysis of Council Adopted Management Measures for 2002 Ocean Salmon Fisheries. April 2002.
- PFMC. 2002c. Review of 2001 Ocean Salmon Fisheries. Pacific Fishery Management Council. February 2002.
- Pearcy, W.G. 1992. Ocean ecology of North Pacific salmonids. Univ. of Washington Press, Seattle, WA. 179p. In August 9, 1996, 61 FR 41545.
- Pearcy, W.G., R.D. Brodeur, and J.P. Fisher. 1990. Distribution and biology of juvenile cutthroat *Oncorhynchus clarki clarki* and steelhead *O. mykiss* in coastal waters off Oregon and Washington. Fish. Bull., U.S. 88(4):697-711. In August 9, 1996, 61 FR 41545.
- Phelps, S.R., S.A. Leider, P.L. Hulett, B.M. Baker, and T. Johnson. 1997. Genetic analyses of Washington steelhead: preliminary results incorporating 36 new collections from 1995 and 1996. Washington Dept. of Fish and Wildlife. February 1997.
- Pitcher, T.J. 1986. Functions of shoaling in teleosts. In Fisher, T.J. (ed.), The behavior of teleost fishes, p. 294-337. Johns Hopkins Univ. Press, Baltimore, MD.
- Quigley, T. M., and S. J. Arbelbide (eds). 1997. An assessment of ecosystem components in the interior Columbia River basin and portions of the Klamath and Great Basins: Volume 3. Gen. Tech. Rep. PNW-GTR-405. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 vol. (Quigley T. M., tech. ed.: The Interior Columbia Basin Ecosystem Management Project: Scientific



Assessment).

- Randall, R.G., M.C. Healey, and J.B. Dempson. 1987. Variability in length of freshwater residence of salmon, trout, and char. In Dodswell, M.J., et al. (eds.), Common strategies of anadromous and catadromous fishes. Am. Fish. Soc. Symp. 1:27-41.
- Reimers, P.E., and R.E. Loeffel. 1967. The length of residence of juvenile fall chinook salmon in selected Columbia River tributaries. Fish Comm. Oreg. 13, 5-19 p.
- Ricker, W.E. 1972. Hereditary and environmental factors affecting certain salmonid populations. In R.C. Simon and P.A. Larkin (eds.), The stock concept in Pacific salmon. MacMillan Lectures in Fisheries. Univ. British Columbia; Vancouver, B.C.
- Roby, D. D., D. P. Craig, K. Collis, and S. L. Adamany. 1998. Avian predation on juvenile salmonids in the lower Columbia River. Report to Bonneville Power Administration and U.S. Army Corps of Engineers. Oregon Cooperative Fish and Wildlife Research Unit, Corvallis, and Columbia River Inter-Tribal Fish Commission, Portland, Oregon. September revision.
- Salo, E.O. 1991. Life history of chum salmon, *Oncorhynchus keta*. In Groot, C., and L. Margolis (eds.), Pacific salmon life histories, p. 231-309. Univ. B.C. Press, Vancouver, B.C., Canada.
- Sands, N. J. 2002. Snake River Fall Estimates. Email to P. Dygert, et al. w/ attached spreadsheet. May 23, 2002.
- Spence, B. C., G. A. Lomnický, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. Prepared by Management Technology for the National Marine Fisheries Service. TR-4501-96-6057. (Available from the NMFS Habitat Branch, Portland, Oregon.)
- Standford, J. A., and J. V. Ward. 1992. Management of aquatic resources in large catchments: recognizing interactions between ecosystem connectivity and environmental disturbance. Pages 91-124 in R. J. Naiman, editor. Watershed management: balancing sustainability and environmental change. Springer-Verlag, New York.
- Technical Advisory Committee (TAC). 1997. 1996 All species review - summer steelhead: Columbia River Fish Management Plan. August 4, 1997. 17 p. w/ tables, tables 8-11 updated.
- TAC. 1999. Recommendations for fall chinook and steelhead management in mainstem Columbia River fisheries - draft. June 22, 1999. 2 p.
- Taylor, E.B. 1991. A review of local adaptation in Salmonidae, with particular reference to

- Pacific and Atlantic salmon. *Aquaculture* 98:185-207.
- Thomas, D. W. 1981. Historical analysis of the Columbia River estuary: An ecological approach. Draft report to the Columbia River Estuary Study Taskforce.
- U.S. v. Oregon Parties. 2000. 2000 Management Agreement for Upper Columbia River fall chinook, steelhead and coho.
- U.S. v. Oregon Parties. 2001. 2001 Management Agreement for Upper Columbia River fall chinook, steelhead and coho. Final Draft. 42 p.
- U.S. v. Oregon Parties. 2002. 2002 Management Agreement for Upper Columbia River fall chinook, steelhead and coho. Final Draft. 41 p.
- Utter, F., G. Milner, G. Stahl, and D. Teel. 1989. Genetic population structure of chinook salmon (*Oncorhynchus tshawytscha*), in the Pacific Northwest. *Fish. Bull.* 87:239-264.
- Viola, A. 2001. WDFW Memo to Bob Leland. PRELIMINARY Summary of the 2000 (PRD) Steelhead Sampling and Stock Assessment Project.
- Washington Department of Fisheries (WDF), Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildl., Olympia, 212p. + 5 regional volumes.
- Washington Department of Fisheries (WDF) and Washington Department of Wildlife (WDW). 1993. 1992 Washington State salmon and steelhead stock inventory - Appendix three Columbia River stocks. June 1993. 580 p.
- Washington Department of Fish and Wildlife (WDFW). 1997. Preliminary stock status update for steelhead in the Lower Columbia. 28 p.
- WDFW. 2001. Fisheries Management and Evaluation Plan - Lower Columbia River. February 21, 2001. 62 p. w/ appendices.
- Waples, R.S., O.W. Johnson, R.P. Jones Jr. 1991. Status review for Snake River sockeye salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS F/NWC-195. 23 p.
- Wilkie, M.P., and 6 co-authors. 1996. Physiology and survival of wild Atlantic salmon following angling in warm summer waters. *Trans. Amer. Fish. Soc.* 125:572-580.
- Withler, I.L. 1966. Variability in life history characteristics of steelhead trout (*Salmo gairdneri*) along the Pacific coast of North America. *J. Fish. Res. Board Can.* 23:365-393. In Busby et al. (1996).

Wydoski, R.S., G.A. Wedemeyer, and N.C. Nelson. 1976. Physiological response to hooking stress in hatchery and wild rainbow trout (*Salmo gairdneri*). Trans. Amer. Fish. Soc. 105: 601-606.